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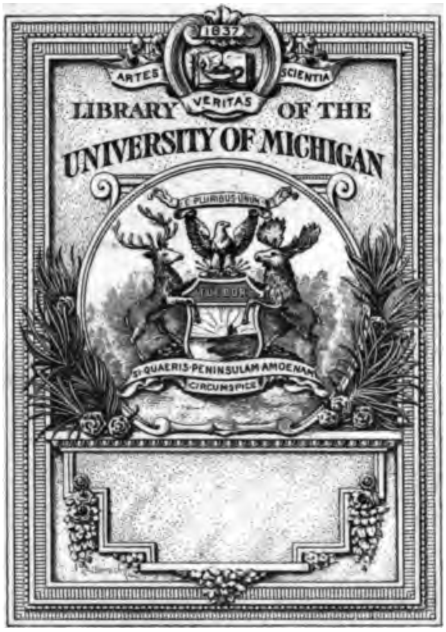

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ANNUAL REPORTS

119766

OF THE

WAR DEPARTMENT

FOR THE

FISCAL YEAR ENDED JUNE 30, 1902.

REPORT OF THE
CHIEF OF ENGINEERS.
PART 2.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1902.

APPENDIXES

TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

(CONTINUED.)

APPENDIX H.

IMPROVEMENT OF RIVERS AND HARBORS IN NEW YORK ON LONG ISLAND SOUND AND ON THE SOUTHERN SHORE OF LONG ISLAND, AND OF RIVERS AND HARBORS IN NORTHERN NEW JERSEY AND DELAWARE.

REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS. OFFICERS IN CHARGE, LIEUT. COL. C. W. RAYMOND AND CAPT. SPENCER COSBY, CORPS OF ENGINEERS.

IMPROVEMENTS.

1. Port Chester Harbor, New York.
2. Mamaroneck Harbor, New York.
3. Larchmont Harbor, New York.
4. Bronx River, New York.
5. East Chester Creek, New York.
6. Mattituck Harbor, New York.
7. Port Jefferson Harbor, New York.
8. Huntington Harbor, New York.
9. Glen Cove, New York.
10. Flushing Bay, New York.
11. Canarsie Bay, New York.
12. Browns Creek, Sayville, Long Island, New York.
13. Patchogue River, New York.
14. Passaic River, New Jersey.
15. Arthur Kill, or Staten Island Sound and channel between Staten Island and New Jersey.
16. Raritan Bay, New Jersey.
17. Harbor at Keyport, New Jersey.
18. Matawan Creek, New Jersey.
19. Raritan River, New Jersey.
20. South River, New Jersey.
21. Elizabeth River, New Jersey.
22. Shoal Harbor and Compton Creek, New Jersey.
23. Shrewsbury River, New Jersey.
24. Manasquan (Squan) River, New Jersey.
25. Delaware River, New Jersey and Pennsylvania.
26. Construction of iron pier in Delaware Bay, near Lewes, Delaware.
27. Delaware Breakwater, Delaware.
28. Construction of harbor of refuge, Delaware Bay, Delaware.
29. Removing sunken vessels or craft obstructing or endangering navigation.

HARBOR LINES.

30. Delaware River in front of League Island Navy-Yard.

ENGINEER OFFICE, U. S. ARMY,
Philadelphia, Pa., July 19, 1902.

GENERAL: I have the honor to transmit herewith the annual reports upon the works of river and harbor improvement under my charge * * * for the fiscal year ending June 30, 1902.

Very respectfully, your obedient servant,

SPENCER COSBY,
Captain, Corps of Engineers

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

H 1.

IMPROVEMENT OF PORT CHESTER HARBOR, NEW YORK.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.]

* * * Detailed description of the harbor and of projects for its improvement are printed in the Annual Report of the Chief of Engineers for 1897, page 1084.

* * * * * * *

OPERATIONS DURING THE PAST FISCAL YEAR.

Nothing in furtherance of the project has been done during the fiscal year, the available funds being insufficient to secure any practical results at a reasonable cost.

* * * * * * *

PROPOSED OPERATIONS.

The available funds and the appropriation of June 13, 1902, will be applied to completing and maintaining the projected channel.

Money statement.

July 1, 1901, balance unexpended	$2,140.29
Amount appropriated by river and harbor act approved June 13, 1902	5,000.00
July 1, 1902, balance unexpended	7,140.29
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902, for maintenance of improvement Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	5,000.00

APPROPRIATIONS.

By act of—		By act of—	
June 10, 1872	$12,000	June 3, 1896	$5,000
August 2, 1882	15,000	March 3, 1899	25,000
August 11, 1888	5,000	June 13, 1902	5,000
September 19, 1890	5,000		
July 13, 1892	5,000	Total	82,000
August 18, 1894	5,000		

COMMERCIAL STATISTICS.

Vessels employed in trade in 1901.

Class.	Trips made.	Tonnage.	Draft.
		Tons.	*Feet.*
Steam	1,600	20 to 268	4 to 10
Sail	100	4 to 600	4 to 13
Barges, etc	600	100 to 800	5 to 10

Freight received and shipped by water, 1901.

	Tons.
Fuel	61,500
Building material	186,000
General merchandise	80,000
Total	327,500

Estimated value of 1901 tonnage, $9,118,000.

H 2.

IMPROVEMENTS OF MAMARONECK HARBOR, NEW YORK.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.]

* * * Detailed description of the harbor and project for its improvement are printed in the Annual Report of the Chief of Engineers for 1900, page 1381.

* * * * * * *

OPERATIONS DURING THE LAST FISCAL YEAR.

Nothing in furtherance of the project has been done during the fiscal year, owing to the lack of sufficient funds.

* * * * * * *

PROPOSED OPERATIONS.

The appropriation of June 13, 1902, will be applied to widening the channel to 100 feet, in accordance with the project.

Money statement.

July 1, 1901, balance unexpended	$88.20
Amount appropriated by river and harbor act approved June 13, 1902	6,000.00
	6,088.20
June 30, 1902, amount expended during fiscal year	48.60
July 1, 1902, balance unexpended	6,039.60
Amount (estimated) required for completion of existing project	5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	5,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

By act of—		By act of—	
August 2, 1882	$15,000	June 13, 1902	$6,000
June 3, 1896	10,000		
March 3, 1899	7,000	Total	38,000

COMMERCIAL STATISTICS.

Freight handled, 1901.

	Tons.
Coal	3,215
Building materials	9,990
General merchandise	7,500
Total	20,705

Vessels engaged in the commerce for 1901.

Class.	Trips made.	Draft when loaded.	Tonnage.
		Feet.	*Tons.*
Steamers	162	7 to 9	50 to 125
Sail vessels	2	5 to 6	50 to 150
Barges	27	6 to 6½	250

The value of the commerce for 1901 was $51,598.

H 3.

IMPROVEMENT OF LARCHMONT HARBOR, NEW YORK.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.]

* * * Detailed description of the harbor and of the present and previous projects for its improvement are printed in Annual Report of the Chief of Engineers for 1900, pages 1383–1387.

* * * * * * *

OPERATIONS DURING THE PAST FISCAL YEAR.

At the beginning of the year work was in progress under a contract with the Anderson-Murphy Company, of New York City, for the delivery of about 83,000 tons of stone in the breakwater, at 54 cents per ton; 68,984 tons had been delivered, and 1,320 linear feet of breakwater partly built.

Work was continued to October 21, 1901, upon which date the contract was completed. The amount of stone delivered this year was 13,967 tons, and the breakwater was extended 90 feet and widened throughout its whole length.

The total amount of stone delivered under this contract was 82,951 tons, and the total length of the breakwater built was 1,410 feet.

The breakwater was built with side slopes of 1 on 1 to a height of 10 feet above the plane of mean low water, or 2½ feet above high water. The top was made 5 feet in width, except at the outer end, where for a length of 25 feet it was made 10 feet wide and 4 feet higher than the general level of the work, to serve as a foundation for a light maintained by the Light-House Establishment.

PRESENT CONDITION OF IMPROVEMENT.

Under a previous project Umbrella breakwater and Huron breakwater were built to lengths of 74 and 64 feet, respectively.

Under the present project the breakwater off Long Beach Point has been built to a length of 1,410 feet, with side slopes of 1 on 1 and top width of 5 feet. Its height is 10 feet above low-water plane. The outer end for a length of 25 feet is 10 feet wide and 14 feet above low water. A light is maintained there by the Light-House Establishment.

PROPOSED OPERATIONS.

Appropriation of June 13, 1902, will be applied to the completion and maintenance of the breakwater off Long Beach Point and to the removal of Huron rock and breakwater.

Money statement.

July 1, 1901, balance unexpended	$13,273.07
Amount appropriated by river and harbor act approved June 13, 1902	10,000.00
	23,273.07
June 30, 1902, amount expended during fiscal year	13,273.07
July 1, 1902, balance unexpended	10,000.00
Amount (estimated) required for completion of existing project	48,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	48,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

By act of—

September 19, 1890	$5,000
March 3, 1899	50,000
June 13, 1902	10,000
Total	65,000

CONTRACT IN FORCE.

Name of contractor: Anderson-Murphy Company.
Date of contract: June 8, 1900.
Date of approval: June 27, 1900.
Date of commencement: On or before July 27, 1900.
Date of completion: On or before June 1, 1901.
Extended to October 21, 1901, when contract was completed.
Furnishing and placing 83,000 tons, more or less, of riprap stone for breakwater, at 54 cents per gross ton.

COMMERCIAL STATISTICS.

Number of vessels other than yachts entering harbor of refuge, or for the night, during 1901 (estimated)		850
Draft of such vessels	feet..	4 to 18
Tonnage of such vessels	tons..	100 to 500

Freight discharged in Larchmont Harbor in 1901.

Number of cargoes	150
Amount in tons	15,500

Vessels owned by the Larchmont Yacht Club.

[Draft, from 3 to 22 feet; tonnage, from 3 to 600 tons.]

Steamers	86
Schooners	51
Sloops	160
Smaller boats	66
Total	363

H 4.

IMPROVEMENT OF BRONX RIVER, NEW YORK.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.] * * *

Detailed history of this improvement was printed in annual report for 1900, pages 1389 to 1391.

* * * * * * *

OPERATIONS DURING THE PAST FISCAL YEAR.

The available funds were not sufficient to attempt any extensive work. Operations this year have been directed toward the removal from the river of a rock ledge, estimated to contain about 125 cubic yards, on the west side of the railroad bridge. This was a serious obstruction and reduced the low-water navigable width of the channel to 20 feet, and was the subject of frequent complaints. The draw of the bridge swings over this ledge, and work could only be carried on at intervals, which made it difficult and expensive. In June, 1901, proposals were invited for this work. One bid only was received; the price—$18 per cubic yard—was considered excessive and was not accepted. Subsequently an offer by Mr. Edwin L. Smart to do the work for $16 per cubic yard was accepted, but the contractor failed after removing 42 cubic yards in September and October, 1901. In March, April, and May, 1902, 76 cubic yards were removed by the Anderson-Murphy Company, under offer dated February 14, 1902, to finish the work for $12 per cubic yard. They also stopped work before completion, but succeeded in increasing the width of the channel to 45 feet, with low-water depth of from 1 to 2 feet. The ledge is probably all broken up to plane of projected depth and can be dredged out at some future time when more funds are available. The total amount of rock removed from this ledge was 118 cubic yards.

PRESENT CONDITION OF IMPROVEMENT.

Thirteen ledges lying within the projected 50-foot channel above Dongan street, and mostly in the vicinity of Westchester avenue Bridge and the railroad bridge, have been removed to depths of 6 feet at mean low water. The ledge at the railroad bridge has been removed to depths of from 1 to 2 feet and broken to 4 feet depth, and part of a reef of rocks and bowlders near the Dye Works dock and the head of navigation has been removed. The depth of the unimproved channel up to Dongan street is 3 feet or more at mean low water, and the bottom is mud and sand. Above Dongan street depths of from 3 to 6 feet can be carried to the railroad bridge; above the railroad bridge, except where rock has been removed to 6 feet, the unimproved channel is from 0 to 2½ feet in depth. The rock removal required under the project is nearly completed.

PROPOSED OPERATIONS.

The available funds and the appropriation of June 13, 1902, will be applied to removing rock obstruction and to dredging.

Money statement.

July 1, 1901, balance unexpended	$3,819.92
June 30, 1902, amount expended during fiscal year	2,345.91
July 1, 1902, balance unexpended	[a]1,474.01
Amount (estimated) required for completion of existing project	55,985.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	55,985.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

By act of–	
June 3, 1896	$10,000
March 3, 1899	20,000
Total	[a]30,000

COMMERCIAL STATISTICS.

	Tons.
Coal	99,000
Lumber	4,000
Building material	50,000
General merchandise	15,000
Total	168,000

The above freight is carried in steamers, sailing vessels, and barges having a tonnage of from 85 to 300 tons and a draft of from 4 to 6 feet.

H 5.

IMPROVEMENT OF EAST CHESTER CREEK, NEW YORK.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.]

* * * Detailed descriptions of the stream and of the project for improvement are printed in the Annual Report of the Chief of Engineers for 1897, pages 1089-1090, and for 1900, page 1387.

* * * * * * *

OPERATIONS DURING THE PAST FISCAL YEAR.

No work was done owing to lack of funds.

* * * * * * *

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[a] This does not include the part of the consolidated appropriation made by act of June 13, 1902, allotment of which has not been made.

PROPOSED OPERATIONS.

The appropriation of June 13, 1902, is to be applied to maintenance of improvement.

Money statement.

July 1, 1901, balance unexpended	$197.53
June 30, 1902, amount expended during fiscal year	98.85
July 1, 1902, balance unexpended	[a] 98.68
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902, for maintenance of improvement Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	5,000.00

APPROPRIATIONS.

By act of—	
March 3, 1873	$25,000
March 3, 1875	12,000
June 18, 1878	10,000
March 3, 1879	3,500
June 14, 1880	3,500
August 5, 1886	10,000
August 11, 1888	$5,000
August 18, 1894	12,000
June 3, 1896	10,000
Total	[a] 91,000

COMMERCIAL STATISTICS.

Vessels employed in trade in 1901.

Class.	Trips made.	Tonnage.	Draft.
			Feet.
Steam	40	5 to 50	6 to 10
Sail	6	200 to 3,000	8
Barges	186	100 to 200	4 to 9

Freight handled.

	Tons.
Coal	50,357
Building material	46,000
General merchandise	129,000
Total	225,357

H 6.

IMPROVEMENT OF MATTITUCK HARBOR, NEW YORK.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.]

* * * Details as to this harbor and the project for improvement are printed in the Annual Report of the Chief of Engineers for 1897, page 1095, and for 1891, page 843.

* * * * * * *

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[a] This does not include the part of the consolidated appropriation made by act of June 13, 1902, allotment of which has not been made.

OPERATIONS DURING THE PAST FISCAL YEAR.

At the close of the fiscal year ending June 30, 1901, work on the west jetty was in progress, under a contract with E. S. Belden, for placing about 8,800 tons of stone, at $1.47 per ton; of this, 8,513 tons had been delivered. This contract was dated August 18, 1900, and expired July 18, 1901; it was completed on July 2, 1901. The amount of stone delivered this year was 268 tons, which was used in raising the outer end of the jetty to a height of 6 feet to make it more conspicuous and to serve as a mark for the entrance channel. The total amount of stone delivered under the contract was 8,781 gross tons.

PRESENT CONDITION OF IMPROVEMENT.

The only work done thus far is that done under the contract mentioned above. The total amount of stone in west jetty is 8,781 gross tons. The jetty has been built to the 10-foot curve in the sound, a distance of 680 feet. It rises to a height of 4 feet above high water except at its outer end, where the height was increased to 6 feet to make it more conspicuous, thereby serving to some extent as an entrance mark. The top width is about 4 feet and the side slopes are 1 on 1. The channel is in its natural condition, which is as follows: From the inlet to the mill dam the depth is about 2 feet at mean low water; above the mill dam the depth is 6 feet at high water. The inlet varies in depth and position owing to the action of storms.

PROPOSED OPERATIONS.

Appropriation recommended will be applied to jetty construction and dredging.

Money statement.

July 1, 1901, balance unexpended	$4,870.92
June 30, 1902, amount expended during fiscal year	4,870.92
Amount (estimated) required for completion of existing project	68,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	30,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

By act of—	
June 3, 1896	$10,000
March 3, 1899	5,000
Total	15,000

CONTRACT IN FORCE DURING YEAR.

Name of contractor: Eugene S. Belden.
Date of contract: August 18, 1900.
Date of approval: August 28, 1900.
Date of commencement: September 19, 1900.
Date of completion: July 18, 1901.
Furnishing in place in jetty about 8,800 gross tons of riprap stone, at $1.47 per gross ton.
Work was completed July 2, 1901.

COMMERCIAL STATISTICS.

The harbor in its present condition is navigated only by small boats (tonnage unknown), and even this is done with difficulty.

The greater part of the freighting to and from Mattituck * * * is done by rail. It is stated on good authority that two lines of freight steamers will stop at Mattituck as soon as the channel is of sufficient capacity to accommodate them.

H 7.

IMPROVEMENT OF PORT JEFFERSON HARBOR, NEW YORK.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.]

* * * Detailed descriptions of the harbor and of previous projects are printed in Annual Reports of Chiefs of Engineers for 1897, page 1097, and for 1900, page 1393.

* * * * * * *

OPERATIONS DURING THE PAST FISCAL YEAR.

Nothing was done in furtherance of the project during the past fiscal year, the available funds being insufficient to secure any practical results.

* * * * * * *

PROPOSED OPERATIONS.

The available balance and the appropriation of June 13, 1902, are to be applied to enlarging the east jetty and to dredging the channel as projected.

Money statement.

July 1, 1901, balance unexpended	$387.32
June 30, 1902, amount expended during fiscal year	75.00
July 1, 1902, balance unexpended	[a]312.32
Amount (estimated) required for completion of existing project	87,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	25,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

For previous project.

By act of—

March 3, 1871	$15,000	
June 10, 1872	15,000	
March 3, 1875	15,000	
August 14, 1876	6,000	
June 18, 1878	8,000	
March 3, 1879	5,000	
June 14, 1880	3,000	
March 3, 1881	4,000	
August 2, 1882	8,000	
		$79,000

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[a] This does not include the part of the consolidated appropriation made by act of June 13, 1902, allotment of which has not been made.

For present project.

By act of—		
September 19, 1890	$25,000	
July 13, 1892	10,000	
August 18, 1894	7,500	
June 3, 1896	7,500	
March 3, 1899	7,500	
		$57,500
Total		[a]136,500

COMMERCIAL STATISTICS.

Vessels employed in trade in 1900.

Class.	Trips made.	Tonnage.	Draft.
			Feet.
Steam	1,742	10 to 1,000	3 to 15
Sail	2,016	15 to 1,500	3 to 14
Barges	46	100 to 500	6 to 10

Freight handled.

	Tons.
Coal	6,500
Grain	4,200
Building material	8,000
General merchandise	19,500
Total	38,200

H 8.

IMPROVEMENT OF HUNTINGTON HARBOR, NEW YORK.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.]

* * * * * * *

Detailed description of the harbor and of the projects for improvement is printed in the Annual Report of the Chief of Engineers for 1897, pages 1100 and 1101.

* * * * * * *

OPERATIONS DURING THE PAST FISCAL YEAR.

No work was done during the year, no funds being available.

* * * * * * *

PROPOSED OPERATIONS.

The appropriation of June 13, 1902, is to be applied to completing and maintaining the channels by means of dredging.

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[a] This does not include the part of the consolidated appropriation, act of June 13, 1902, allotment of which has not been made.

Money statement.

July 1, 1901, balance unexpended	$10.94
July 1, 1902, balance unexpended	[a]10.94

Amount (estimated) required for completion of existing project		2,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$2,500.00	
For maintenance of improvement	2,500.00	
		5,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

By act of—		By act of—	
June 10, 1872	$22,500	June 3, 1896	$5,000
September 19, 1890	10,000	March 3, 1899	7,500
July 13, 1892	5,000		
August 18, 1894	2,000	Total	[a]52,000

COMMERCIAL STATISTICS.

Vessels employed in trade in 1901.

Class.	Trips made.	Tonnage.	Draft.
			Feet.
Steam	700	125 to 250	6 to 8
Sail	175	50 to 250	5 to 12
Barges, etc	90	200	5 to 6½

Freight handled.

	Tons.
Coal	9,000
Building material	20,000
Grain	5,000
General merchandise	18,000
Total	52,000

The value of the merchandise carried during 1901 was $875,800.

H 9.

IMPROVEMENT OF GLEN COVE HARBOR, NEW YORK.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.]

* * * * * * *

Details concerning the harbor and project for improvement are printed in the Annual Report of the Chief of Engineers for 1897, page 1103.

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[a] This does not include the part of the consolidated appropriation, act of June 13, 1902, allotment of which has not been made.

OPERATIONS DURING THE PAST FISCAL YEAR.

Nothing was done during the fiscal year owing to lack of funds.

* * * * * * *

PROPOSED OPERATIONS.

The appropriation of June 13, 1902, will be applied to breakwater construction, in accordance with the project.

Money statement.

July 1, 1902, balance unexpended	([a])
Amount (estimated) required for completion of existing project	$72,000
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	10,000
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

By act of—		By act of—	
August 11, 1888	$20,000	June 3, 1896	$8,000
September 19, 1890	15,000		
July 13, 1892	10,000	Total	[a]63,000
August 18, 1894	10,000		

COMMERCIAL STATISTICS.

A statement of the commerce for the calendar year 1901 was asked for, but was not received

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H 10.

IMPROVEMENT OF FLUSHING BAY, NEW YORK.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.]

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Details in reference to this improvement may be found on page 1106, Annual Report of the Chief of Engineers for 1897.

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OPERATIONS DURING THE PAST FISCAL YEAR.

No work was done during the year owing to lack of funds.

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PRESENT CONDITION OF IMPROVEMENT.

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No shoaling has been reported during the year.

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[a] Allotment from consolidated appropriation made by act of June 13, 1902, has not been made.

PROPOSED OPERATIONS.

The appropriation of June 13, 1902, is to be applied to maintaining and widening the dredged channel.

Money statement.

July 1, 1901, balance unexpended	$504.47
June 30, 1902, amount expended during fiscal year	45.00
July 1, 1902, balance unexpended	[a] 459.47
Amount (estimated) required for completion of existing project	50,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	5,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

By act of—		By act of—	
March 3, 1879	$20,000	September 19, 1890	$20,000
June 14, 1880	15,000	July 13, 1892	10,000
March 3, 1881	10,000	August 18, 1894	4,000
August 2, 1882	5,000	June 3, 1896	4,000
July 5, 1884	10,000		
August 5, 1886	10,000	Total	[a] 123,000
August 11, 1888	15,000		

COMMERCIAL STATISTICS.

Vessels employed in trade in 1901.

Class.	Trips made.	Tonnage.	Draft.
		Tons.	*Feet.*
Steam	1,550	100 to 150	7 to 7½
Sail vessels	200	150 to 450	6 to 14
Barges, etc	1,200	100 to 1,000	6 to 14

Freight received and shipped by water.

	Tons.
Coal	44,600
Fertilizers	38,000
Building material	16,908
Dyewoods	30,000
Paving material	21,565
General merchandise	49,400
Total	200,473

The value of the commerce in 1901 was $4,196,406.

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[a] This does not include the part of the consolidated appropriation, act of June 13, 1902, allotment of which has not been made.

H 11.

IMPROVEMENT OF CANARSIE BAY, NEW YORK.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.]

* * * Description of the locality and the project for improvement is printed in the Annual Report of the Chief of Engineers for 1897, page 1114.

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OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1902.

Sufficient funds were not available, and therefore no work was done.

* * * * * * *

PROPOSED OPERATIONS.

The appropriation of June 13, 1902, is to be applied to widening and maintaining the dredged channels.

Money statement.

July 1, 1901, balance unexpended	$522.92
June 30, 1902, amount expended during fiscal year	97.10
July 1, 1902, balance unexpended	[a]425.82
Amount (estimated) required for completion of existing project	23,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	23,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

By act of—		By act of—	
June 14, 1800	$10,000	September 19, 1890	$5,000
March 3, 1881	5,000	July 13, 1892	5,000
August 2, 1882	3,000	August 18, 1894	2,000
July 5, 1884	5,000	June 3, 1896	10,000
August 5, 1886	10,000		
August 11, 1888	10,000	Total	[a]65,000

COMMERCIAL STATISTICS.

* * * The tonnage of oysters and clams was reported for the year 1901 as 450,000 tons, valued at $2,000,000. Lumber, coal, ice, and bricks also make up a large part of the commerce. The amount was not reported.

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[a] This does not include the part of the consolidated appropriation act of June 13, 1902, allotment of which has not been made.

H 12.

IMPROVEMENT OF BROWNS CREEK, SAYVILLE, LONG ISLAND, NEW YORK.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.]

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Detailed description of this improvement is printed in the Annual Report of the Chief of Engineers for 1897, pages 1111 to 1114.

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OPERATIONS DURING THE PAST FISCAL YEAR.

Nothing in furtherance of the project has been done during the year.

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PROPOSED OPERATIONS.

The available funds and the appropriations recommended will be applied to extending and maintaining the channel by dredging.

Money statement.

July 1, 1901, balance unexpended	$463.45
June 30, 1902, amount expended during fiscal year	90.47
July 1, 1902, balance unexpended	372.98
Amount (estimated) required for completion of existing project	18,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	5,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

By act of—		By act of—	
September 19, 1890	$12,000	March 3, 1899	$3,000
July 13, 1892	5,000		
August 18, 1894	4,000	Total	28,000
June 3, 1896	4,000		

COMMERCIAL STATISTICS.

Vessels employed in trade in 1901.

Class.	Number of vessels.	Tonnage.	Draft.
			Feet.
Steam	14	10 to 15	4 to 5
Sail	210	2½ to 60	2 to 6
Barges	16	5 to 20	1 to 2

Freight received and shipped by water.

	Tons.
Building material	2,000
Fish	525
Shellfish	14,500
Total	17,025

The value of the commerce in 1901 was $454,500.

H 13.

IMPROVEMENT OF PATCHOGUE RIVER, NEW YORK.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.]

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Detailed description of the river and of the first project for its improvement is printed in the Annual Report of the Chief of Engineers for 1897, pages 1108 to 1111.

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OPERATIONS DURING THE PAST FISCAL YEAR.

Work done this year consisted in dredging for maintenance with a small balance of funds remaining from last appropriation. The work was done under an agreement with Mr. Frank Perkinson, dated July 3, 1901; it was commenced July 15 and completed on July 23, 1901. Two thousand nine hundred and fifty-six cubic yards of mud were removed from the channel. One cut, 35 feet wide and from 6½ to 7 feet deep at mean low water, was made from the outer end of the jetty a length of about 1,200 feet up the channel, removing all shoals complained of. The price paid for this work was 19 cents per cubic yard.

PRESENT CONDITION OF IMPROVEMENT.

The jetty at the mouth of the river has been made 1,700 feet long.

The channel has been dredged 60 feet wide and 6 feet deep at mean low water from Great South Bay to 80 feet from the harbor lines at the head of the harbor. At the upper part, for 300 feet length, it was made 100 feet wide to allow vessels to turn about.

PROPOSED OPERATIONS.

The appropriation of June 13, 1902, will be expended in carrying out the work proposed under the new project.

This work will be continued under the title "Improving Fire Island Inlet, N. Y."

Money statements.

PATCHOGUE RIVER.

July 1, 1901, balance unexpended	$706.85
June 30, 1902, amount expended during fiscal year	706.85

FIRE ISLAND INLET.

Amount appropriated by river and harbor act approved June 13, 1902	$66,000
July 1, 1902, balance unexpended	66,000

APPROPRIATIONS.

For first project.

By act of—		
September 19, 1890	$15,000	
July 13, 1892	8,000	
August 18, 1894	4,000	
June 3, 1896	13,000	
		$40,000

For present project.

By act of June 13, 1902	66,000
Total for both projects	106,000

COMMERCIAL STATISTICS.

Vessels employed in trade, in 1901.

Class.	Trips made.	Tonnage.	Draft.
			Feet.
Steam	1,350 to 1,500	20 to 70	3 to 5
Sail	7,500 to 8,200	3 to 300	3 to 8
Barges, etc	4,750	30 to 100	2 to 5

Freight handled.

	Tons.
Coal	14,700
Lumber	225,000
Fish and shellfish	5,500
General merchandise	36,100
Total	281,300

The estimated value of the tonnage for 1901, is $34,025,000

H 14.

IMPROVEMENT OF PASSAIC RIVER, NEW JERSEY.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.]

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Detailed descriptions of this river and of projects for the improvement are printed in the Annual Reports of the Chief of Engineers for 1897, pages 1128 and 1129, and for 1900, pages 1530 to 1550.

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OPERATIONS DURING THE PAST FISCAL YEAR.

In July, 1901, an allotment of $1,000 from emergency river and harbor act of June 6, 1900, was asked for and received, with which to remove a shoal north of the Center Street Bridge, Newark, but as a reasonable bid could not be obtained for doing the work, the money was not expended,

PRESENT CONDITION OF IMPROVEMENT.

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The required depth has been attained at Belleville bar for widths of 50 to 100 feet, at Rutherford Park bar for widths of 85 to 100 feet, and above Rutherford Park bar to Passaic City for narrow widths.

PROPOSED OPERATIONS.

The available balance and appropriation of June 13, 1902, are to be applied to work under the new project below Newark, andm aintenance work above Newark.

Money statement.

July 1, 1901, balance unexpended		$40.00
July 12, 1901, amount allotted from appropriation for emergencies in river and harbor works		1,000.00
Amount appropriated by river and harbor act approved June 13, 1902		75,000.00
		76,040.00
June 30, 1902, amount expended during fiscal year		40.00
July 1, 1902, balance unexpended		76,000.00
Amount (estimated) required for completion of existing project		264,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$100,000.00	
For maintenance of improvement	5,000.00	
		105,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

By act of—		By act of—	
June 10, 1872	$25,000	August 5, 1886	$26,250
March 3, 1873	25,000	August 11, 1888	35,000
June 23, 1874	20,000	September 19, 1890	45,100
March 3, 1875	20,000	July 13, 1892	45,000
August 10, 1876	10,000	August 18, 1894	15,000
June 18, 1878	10,000	June 3, 1896	15,000
March 3, 1879	2,000	March 3, 1899	15,000
June 14, 1880	32,000	June 6, 1900 (allotment)	1,000
March 3, 1881	50,000	June 13, 1902	75,000
August 2, 1882	50,000		
July 5, 1884	28,000	Total	544,350

COMMERCIAL STATISTICS.

Freight handled and shipped by water, 1901.

	Tons.
Building materials	514,593
Ores and metals	175,400
Fertilizers	37,000
Coal	140,115
Miscellaneous merchandise	677,825
To and from Hackensack River	464,423
Total	2,009,356

The commerce is carried on in sail and steam vessels, canal boats, and barges drawing from 5 to 14 feet of water.

At the United States custom-house, Newark, N. J., on the Passaic River, during 1901 the number of ships that entered and cleared was 168, and the tonnage was 39,392 tons.

H 15.

IMPROVEMENT OF ARTHUR KILL OR STATEN ISLAND SOUND AND CHANNEL BETWEEN STATEN ISLAND AND NEW JERSEY.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.]

* * * * * * *

Detailed descriptions of this waterway and of the projects for its improvement are printed in the Annual Reports of the Chief of Engineers for 1897, pages 1130 to 1132, and for 1900, page 1525, and in House Doc. No. 393, Fifty-sixth Congress, first session.

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OPERATIONS DURING THE PAST FISCAL YEAR.

Nothing has been done during the year, as the available funds were insufficient to secure any useful results.

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PROPOSED OPERATIONS.

The available balance and the appropriation of June 13, 1902, are to be applied to work under the new project and to maintenance.

Money statement.

July 1, 1901, balance unexpended		$2,018.50
Amount appropriated by river and harbor act approved June 13, 1902 (including $5,000 for Lemon Creek, New York)		110,000.00
		112,018.50
June 30, 1902, amount expended during fiscal year		167.62
July 1, 1902, balance unexpended		111,850.88
Amount (estimated) required for completion of existing project		596,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$200,000.00	
For maintenance of improvement	5,000.00	
		205,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

APPROPRIATIONS.

By act of—		By act of—	
June 23, 1874	$50,000	September 19, 1890	[a]$22,000
August 14, 1876	10,000	July 13, 1892	[b]20,000
June 18, 1878	15,000	August 18, 1894	[c]10,500
June 14, 1880	29,000	June 3, 1896	[c]13,000
August 2, 1882	40,000	March 3, 1899	32,000
July 5, 1884	10,000	June 13, 1902	[d]110,000
August 5, 1886	15,000		
August 11, 1888	25,000	Total	401,500

COMMERCIAL STATISTICS.

Freight received and shipped by water, 1901.

	Tons.
Coal and ores	9,948,990
Clay products	91,849
Chemicals and fertilizers	241,455
Oils	64,129
Machinery and manufactures	764,225
General merchandise	540,652
Total	11,651,300

The above statement is based on individual reports representing a large percentage of the total tonnage reported.

The commerce for the year 1901 was valued at $165,199,487.

The freights are carried in barges, canal boats, and steam and sailing vessels, drawing from 5 to 23 feet of water.

H 16.

IMPROVEMENT OF RARITAN BAY, NEW JERSEY.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.

* * * * * * *

Detailed description of the bay and of the project for improvement are printed in the Annual Report of the Chief of Engineers for 1897, pages 1142 and 1143.

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OPERATIONS DURING THE PAST FISCAL YEAR.

No work was done during the year, the funds on hand being insufficient in amount to effect any material improvement in the dredged channels.

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[a] Includes appropriations made for improving Arthur Kill, New York and New Jersey.

[b] Unexpended balance from appropriation for improving Arthur Kill, New York and New Jersey.

[c] Includes $5,000 for Lemon Creek.

[d] Includes $5,000 for Lemon Creek and $100,000 for Arthur Kill, New York and New Jersey, new project.

PROPOSED OPERATIONS.

The appropriation of June 13, 1902, is to be applied to dredging the channels to their full dimensions and in maintaining the portions already completed.

July 1, 1901, balance unexpended		$930.00
Amount appropriated by river and harbor act approved June 13, 1902		45,000.00
July 1, 1902, balance unexpended		45,930.00
Amount (estimated) required for completion of existing project		164,375.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$50,000.00	
For maintenance of improvement	20,000.00	
		70,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

APPROPRIATIONS.

By act of—		By act of—	
March 3, 1881	$50,000	August 18, 1894	$40,000
August 2, 1882	50,000	June 3, 1896	75,000
July 5, 1884	20,000	March 3, 1899	65,000
August 5, 1886	37,500	June 13, 1902	45,000
August 11, 1888	25,000		
September 19, 1890	40,000	Total	487,500
July 13, 1892	40,000		

COMMERCIAL STATISTICS.

Freight received and shipped by water, 1901.

	Tons.
Coals, ores, etc	3,849,522
Lumber	74,652
Building material	592,315
Fertilizers	23,597
Manufactures	62,987
Merchandise	118,975
Total	4,722,048

Vessels employed in trade.

Class.	Trips made.	Tonnage.	Draft.
			Feet.
Steamers	10,020	50 to 1,000	7 to 23
Sail vessels	15,050	3 to 800	3 to 23
Barges, etc	44,309	100 to 2,000	7 to 23

The value of the commerce in 1901 was estimated at $49,310,429.

H 17.

IMPROVEMENT OF HARBOR AT KEYPORT, NEW JERSEY.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.]

* * * * * * *

A detailed description of this locality and a history of the work done are printed in the Annual Report of the Chief of Engineers for 1897, pages 1147 to 1149.

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OPERATIONS DURING THE PAST FISCAL YEAR.

No work was done during the year, owing to lack of funds.

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PROPOSED OPERATIONS.

The appropriation of June 13, 1902, is to be expended in extending the channel and maintaining the improvement made.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902		([a])
Amount (estimated) required for completion of existing project		$9,975.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$9,975.00	
For maintenance of improvement	5,000.00	
		14,975.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

By act of—		By act of—	
August 2, 1882	$30,475	June 3, 1896	$2,500
July 13, 1892	5,000	March 3, 1899	2,500
August 18, 1894	5,000		
		Total	[a]45,475

COMMERCIAL STATISTICS.

Freight received and shipped by water, 1901.

	Tons.
Farm produce	15,000
Fertilizers	5,000
Coal and lumber	6,000
Fish and shellfish	12,000
Miscellaneous	7,000
Total	45,000

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[a] Allotment from consolidated appropriation made by act of June 13, 1902, has not been made.

To the above should be added the commerce of Matawan Creek, New Jersey, as it passes in and out through Keyport Harbor. * * *

The freight in 1901 was carried in 2 steamers, 60 to 70 sail vessels, and 125 barges, drawing from 5 to 10 feet, and with a tonnage of from 5 to 500 tons.

H 18.

IMPROVEMENT OF MATAWAN CREEK, NEW JERSEY.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.]

* * * * * * *

A detailed description of this locality and of the work done is printed in the Annual Report of the Chief of Engineers for 1897, pages 1145 and 1146.

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OPERATIONS DURING THE PAST FISCAL YEAR.

No work was done during the year, no funds being available.

PRESENT CONDITION OF IMPROVEMENT.

The existing project has never been completed. When work was last suspended the channel had a least width of 80 feet at the outlet into Keyport Harbor, and a least width of 40 feet in the creek as far up as the steamboat dock at Matawan, the depth being 4 feet, except for a short distance below the Matawan steamboat dock, where it was 3½ feet on the south side of the channel.

The amount required for completion of existing project has been increased by $21,120, which amount has been expended from time to time in maintaining work already accomplished.

PROPOSED OPERATIONS.

The appropriation of June 13, 1902, is to be expended in extending the channel and maintaining the improvements already made.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902		([a])
Amount (estimated) required for completion of existing project		$12,120.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$6,000.00	
For maintenance of improvement	3,000.00	
		9,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

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[a] Allotment from consolidated appropriation made by act of June 13, 1902, has not been made.

APPROPRIATIONS.

By act of—	
March 3, 1881	$15,000
August 2, 1882	6,000
September 19, 1890	2,500
July 13, 1892	9,620
August 18, 1894	3,000
June 3, 1896	$3,000
March 3, 1899	3,000
Total	[a]42,120

COMMERCIAL STATISTICS.

Freight received and shipped by water, 1901.

	Tons.
Farm produce and general merchandise	35,000
Brick	20,000
Fertilizers	5,000
Total	60,000

The commerce of 1901 was carried in barges, canal boats, steam and sail vessels, draft 5 to 8 feet, carrying 50 to 600 tons.

The statement of commerce is approximate only, based on the incomplete returns furnished. The value of the commerce can not be obtained.

H 19.

IMPROVEMENT OF RARITAN RIVER, NEW JERSEY.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.]

* * * * * * *

Detailed description of this improvement is printed in the Annual Report of the Chief of Engineers for 1897, pages 1136–1139, and for further information as to this project, see Report for 1900, page 1505.

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OPERATIONS DURING THE PAST FISCAL YEAR.

No work was done during the fiscal year, as the balance of funds was too small for any useful work under the project.

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PROPOSED OPERATIONS.

The appropriation of June 13, 1902, is to be expended in widening the channel between Whiteheads Dock and New Brunswick, and in maintaining the work already accomplished.

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[a] This does not include the part of the consolidated appropriation, act of June 13, 1902, allotment of which has not been made.

Money statement.

July 1, 1901, balance unexpended	$3,550.00
June 30, 1902, amount expended during fiscal year	195.00
July 1, 1902, balance unexpended	[a]3,355.00
Amount (estimated) required for completion of existing project	363,750.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:	
For works of improvement $50,000.00	
For maintenance of improvement 10,000.00	
	60,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

APPROPRIATIONS.

By act of—	
June 18, 1878	$200,000
March 3, 1879	60,000
June 14, 1880	100,000
March 3, 1881	25,000
August 2, 1882	25,000
July 5, 1884	35,000
August 5, 1886	26,250
August 11, 1888	50,000
September 19, 1890	$50,000
July 13, 1892	40,000
August 18, 1894	20,000
June 3, 1896	20,000
March 3, 1899	20,000
Total	[b]671,250

COMMERCIAL STATISTICS.

Freight received and shipped by water, 1901.

	Tons.
Coal, clay, ores, etc	476,098
Manufactures	597,265
Lumber	73,145
Miscellaneous	120,442
Total	1,266,950

Vessels engaged in the commerce for 1901.

Class.	Trips made.	Draft when loaded.	Tonnage.
		Feet.	*Tons.*
Steamers	3,106	5 to 10	50 to 150
Sail vessels	8,150	3 to 17	10 to 750
Barges, etc	15,768	5 to 12	50 to 400

The value of the commerce in 1901 was $15,550,539.

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[a] This does not include the part of the consolidated appropriation made by act of June 13, 1902, allotment of which has not been made.

[b] This does not include the part of the consolidated appropriation act of June 13, 1902, allotment of which has not been made. In addition to the above, $13,963 was appropriated for improving New Brunswick Harbor, New Jersey, in 1836–37.

H 20.

IMPROVEMENT OF SOUTH RIVER, NEW JERSEY.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12,1902.]

* * * A description of this stream and a history of the work done are printed in the Annual Report of the Chief of Engineers for 1897, pages 1139–1140.

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OPERATIONS DURING THE PAST FISCAL YEAR.

No work was done during the fiscal year, as no funds were available.

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PROPOSED OPERATIONS.

The appropriation of June 13, 1902, is to be applied to maintenance work.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902		([a])
Amount (estimated) required for completion of existing project		$98, 975.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$20, 000.00	
For maintenance of improvement	5, 000.00	
		25, 000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

APPROPRIATIONS.

For previous project.

By act of—		
March 3, 1871	$15, 000	
March 3, 1873	5, 000	
		$20, 000

For present project.

By act of—		
June 14, 1880	$40, 000	
March 3, 1881	6, 000	
August 2, 1882	10, 000	
August 5, 1886	$5, 000	
August 11, 1888	5, 000	
September 19, 1890	5, 000	
July 13, 1892	7, 000	
August 18, 1894	5, 000	
June 3, 1896	5, 000	
March 3, 1899	5, 000	
		$93, 000
Total, for both projects		[a]113, 000

COMMERCIAL STATISTICS.

Freight received and shipped by water, 1901.

	Tons.
Coal, clay, ore, etc	59, 100
Manufactures, brick, etc	248, 886
Miscellaneous	20, 200
Total	328, 186

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[a] Allotment from consolidated appropriation made by act of June 13, 1902, has not been made.

Vessels engaged in the commerce for 1901.

Class.	Trips made.	Draft when loaded.	Tonnage.
		Feet.	*Tons.*
Steamers	1,550	6 to 9	40 to 75
Sail vessels	575	3 to 13	35 to 300
Barges, etc	2,786	3 to 9	75 to 200

The value of the commerce of 1901 was estimated at $968,458.

H 21.

IMPROVEMENT OF ELIZABETH RIVER, NEW JERSEY.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.]

* * * * * * *

A history of this work and a description of the locality are given in the Annual Report of the Chief of Engineers for 1897, pages 1134, 1135.

* * * * * * *

OPERATIONS DURING THE PAST FISCAL YEAR.

No work was done during the year, no funds being available.

* * * * * * *

PROPOSED OPERATIONS.

The appropriation of June 13, 1902, is to be applied to increasing the dimensions of the channel and maintaining that already secured by dredging.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902		([a])
Amount (estimated) required for completion of existing project		$16,160.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to tne balance unexpended July 1, 1902:		
For works of improvement	$8,000.00	
For maintenance of improvement	5,000.00	
		13,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

By act of—		By act of—	
March 3, 1879	$7,500	July 13, 1892	$5,000
June 14, 1880	7,500	August 18, 1894	3,000
March 3, 1881	4,000	June 3, 1896	3,160
August 2, 1882	8,000		
September 19, 1890	5,000	Total	[a]43,160

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[a] Allotment from consolidated appropriation made by act of June 13, 1902, has not been made.

COMMERCIAL STATISTICS.

Freight received and shipped by water, 1901.

	Tons.
Coal	8,835
Lumber	3,000
Building material	15,647
Miscellaneous	2,013
Total	29,495

During 1901 the above freight was carried in sailing vessels, barges, canal boats, and tank boats, drawing from 4 to 8 feet loaded, with a tonnage varying from 40 to 400 tons.

The total number of trips was about 375.

The value of the commerce for 1901 has not been reported.

H 22.

IMPROVEMENT OF SHOAL HARBOR AND COMPTON CREEK, NEW JERSEY.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31, to June 12, 1902.]

* * * * * * *

A detailed description of this locality and a history of the work done are printed in the Annual Report of the Chief of Engineers for 1897, pages 1150 and 1151.

* * * * * * *

OPERATIONS DURING THE PAST FISCAL YEAR.

No work was done during the year, owing to lack of funds.

* * * * * * *

PROPOSED OPERATIONS.

The appropriation of June 13, 1902, is to be applied to extending and maintaining the channel already made, by means of dredging.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902		([a])
Amount (estimated) required for completion of existing project		$47,130.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$15,000.00	
For maintenance of improvement	5,000.00	
		20,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

[a] Allotment from consolidated appropriation made by act of June 13, 1902, has not been made.

APPROPRIATIONS.

By act of—		By act of—	
September 19, 1890	$5,000	March 3, 1899	$8,000
July 13, 1892	5,000		
August 18, 1894	3,000	Total	[a]24,000
June 3, 1896	5,000		

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[a] This does not include the part of the consolidated appropriation, act of June 13, 1902, allotment of which has not been made.

COMMERCIAL STATISTICS.

Freight received and shipped by water, 1901.

	Tons.
Farm produce	80,000
Fish and shellfish	85,000
Coal	5,000
Fertilizers	9,000
Miscellaneous	1,000
Total	180,000

The commerce in 1901 was handled in one steamer, 250 sailboats, and 100 gasoline boats, drawing from 2 to 6 feet of water when loaded, with a tonnage varying from 5 to 420 tons.

The value of the commerce in 1901 was $2,960,500.

H 23.

IMPROVEMENT OF SHREWSBURY RIVER, NEW JERSEY.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.]

* * * * * * *

Detailed description of this river and of projects for its improvement are printed in Annual Report of the Chief of Engineers for 1897, pages 1152 to 1155, and for 1900, page 185.

* * * * * * *

OPERATIONS DURING THE PAST FISCAL YEAR.

At the close of the fiscal year ending June 30, 1901, work was in progress under a contract with the Shrewsbury Dredging Company, of Long Branch, N. J., for redredging the channel in the main stem east of Island Beach. A channel had been made across the shoal 6 feet deep and 40 feet wide for a distance of 1,025 feet. The total quantity of sand that had been removed was 19,250 cubic yards, at a cost of 24.6 cents per cubic yard; 13.7 cubic yards of stone was also removed, at a cost of $8 per cubic yard; and 85 piles, forming an old dock, were drawn at a cost of $2 each.

This work was continued until the last of September, 1901, at which time the contract was completed.

The work done during the year consisted in the removal of 12,590 cubic yards of sand, 3.42 cubic yards of rock, and 1 pile, all at the prices named above, and the channel across the shoal was widened to 80 feet. The total work done under this contract was the removal of 31,840 cubic yards of sand, 17.12 cubic yards of stone, and 86 piles. One cut 1,600 feet long and one cut 900 feet long, each 40 feet in width and 6 feet in depth at mean low water, were made through the shoal east of Island Beach.

PRESENT CONDITION OF IMPROVEMENT.

In the main stem, channels of the required dimensions have been dredged across the shoals and partly maintained at the outer bar by a training dike.

In the North Branch channels 6 feet deep and from 100 to 200 feet wide have been secured by dredging and training dikes.

In the South Branch training dikes have been built and channels dredged to the required depth.

PROPOSED OPERATIONS.

The appropriations of June 13, 1902, will be expended in increasing the dimensions of the channels and in maintaining those now existing by dredging and by the construction of dikes.

Money statement.

July 1, 1901, balance unexpended	$6,718.00
Amount appropriated by river and harbor act approved June 13, 1902	75,000.00
	81,718.00
June 30, 1902, amount expended during fiscal year	6,718.00
July 1, 1902, balance unexpended	75,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement in addition to the balance unexpended July 1, 1902	10,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

For previous project.		
By act of—		
August 30, 1852	$1,500	
March 3, 1871	14,000	
March 3, 1873	5,000	
		$20,500
For present project.		
June 18, 1878	18,000	
March 3, 1879	10,000	
June 14, 1880	30,000	
March 3, 1881	86,000	
August 2, 1882	30,00	
August 5, 1886	10,00	
August 11, 1888	10,000	
September 19, 1890	10,000	
July 13, 1892	10,000	
August 18, 1894	5,000	
June 3, 1896	15,000	
March 3, 1899	10,000	
June 6, 1900, allotment	10,000	
June 13, 1902	75,000	
		329,000
Total for both projects		349,500

ABSTRACT OF CONTRACT IN FORCE.

Name of contractor: Shrewsbury Dredging Company.
Date of contract: July 20, 1900.
Date of approval: September 14, 1900.
Date of commencement: September 28, 1900.

Date of completion: January 25, 1901.

Removal of about 30,060 cubic yards of sand at 24.6 cents per cubic yard; of 86 piles, at $2 each, and of 17.12 cubic yards of stone, at $8 per cubic yard.

Work was continued under an implied contract with the same company and under the same terms, by authority of the Chief of Engineers, dated February 15, 1901, and was completed September 30, 1901.

COMMERCIAL STATISTICS.

Freight handled, 1901.

	Tons.
Farm produce	150,000
Fish and shellfish	10,000
Coal	20,000
Lumber	1,000
Building material	7,000
Miscellaneous	300,000
Total	488,000

Passengers carried, 209,204, in 1901.

H 24.

IMPROVEMENT OF MANASQUAN (SQUAN) RIVER, NEW JERSEY.

[This work was in the charge of Col. S. M. Mansfield, Corps of Engineers, to January 31, 1902, and in the charge of Lieut. Col. C. W. Raymond, Corps of Engineers, from January 31 to June 12, 1902.]

* * * * * * *

A history of this improvement may be found in Annual Report of the Chief of Engineers for 1898, page 1070.

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OPERATIONS DURING THE PAST FISCAL YEAR.

No work was done during the year, as the funds on hand would not permit of the construction of a sufficient length of the proposed south dike to result in any benefit to navigation.

* * * * * * *

PROPOSED OPERATIONS.

The balance available will be retained until another appropriation shall have been made, with the expectation that the expenditure of a larger amount of money will enable the work to be done more economically.

Money statement.

July 1, 1901, balance unexpended	$5,925.00
July 1, 1902, balance unexpended	5,925.00
Amount (estimated) required for completion of existing project	14,375.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	14,375.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

By act of—			
March 3, 1879	$12,000	By act of—	
June 14, 1880	20,000	March 3, 1899	$5,000
August 2, 1882	7,000		
September 19, 1890	2,000	Total	46,000

COMMERCIAL STATISTICS.

The commerce of this river amounts practically to nothing, owing to obstructions at the inlet. The river is largely used by pleasure craft during the summer season.

H 25.

IMPROVEMENT OF DELAWARE RIVER, NEW JERSEY AND PENNSYLVANIA.

An account of this improvement is contained in the Annual Reports of the Chief of Engineers for 1896, page 877; 1897, page 1192; 1898, page 1075; 1899, page 1317; 1900, page 1557, and 1901, page 1310.

Expenditures during the past fiscal year have been applied to the following operations:

1. Surveys of the channel between Marcushook and Eddystone; between Black's wharf and Gloucester; from Fishers Point to Torresdale, west of Petty Island, and at Baker shoal.
2. Removal of rock from the channel opposite Petty Island.
3. Improvement of Dan Baker shoal (Subsection B, section 1).

These operations will be described in the above order. The localities referred to and previous operations thereat are described in the Annual Reports of the Chief of Engineers for 1896, pages 1075–1079, and 1899, pages 1317–1322.

1. SURVEYS.

Between Marcushook and Eddystone.—This survey was for the purpose of obtaining additional information in connection with the survey made from Marcushook to League Island during the fiscal year ending June 30, 1901.

Between Black's wharf and Gloucester.—This survey was made for the purpose of determining the shore lines between Black's wharf and Gloucester and the condition of the river channels between the limits of the survey. No recent survey of this section had been made.

From Fisher's Point to Torresdale.—This survey was made for the purpose of determining shore lines between Fishers Point and Torresdale and included the hydrography of the river between the limits of the survey. This survey covers the entire river front of the city of Philadelphia north of Fishers Point.

West of Petty Island.—This survey was made to determine the changes in the water front and channel west of Petty Island, and is a continuation of the survey made south and east of Petty Island during the fiscal year ending June 30, 1901.

At Baker shoal.—This survey was made for the purpose of determining the condition and tendency of the channel which had been dredged for a distance of 20,500 feet through the upper part of the shoal.

2. REMOVAL OF ROCK OPPOSITE PETTY ISLAND.

A project for the expenditure of $125,000 of the appropriation made in the river and harbor act of March 3, 1899, to be used for removing rock from the channel of the river opposite Petty Island (above Christian street, Philadelphia), was submitted on June 6, 1899, and approved June 14, 1899.

Under date of August 11, 1899, a contract was entered into with P. Sanford Ross, Incorporated, of Jersey City, N. J., for the removal of about 6,499 cubic yards of rock in the channel of the river at this locality, together with the overlying and adjacent material, so as to form a clear channel with a least depth of 26 feet at mean low water. Work under this contract was commenced on October 7, 1899, and completed on November 21, 1901.

Up to June 30, 1901, 18,895 cubic yards of rock and overlying material, scow measurement, had been removed from the ledge. The removal of this material represented the removal of about 5,986 cubic yards of ledge rock, place measurement. During the past fiscal year 3,135 cubic yards of rock and overlying material were removed from the ledge, making a total of 22,030 cubic yards removed under the contract. Of the material removed, about 6,640 cubic yards were ledge rock and bowlders. By the work done a clear channel 26 feet deep at mean low water has been obtained over the entire rock area, which was carefully sounded and swept after the completion of operations.

3. IMPROVEMENT AND SURVEY OF BAKER SHOAL (SUBSECTION B, SECTION 1).

* * * The project provides for a channel 600 feet wide and 30 feet deep from Christian street, Philadelphia, to deep water in Delaware Bay, and further provides for the application of the expenditure then authorized by law to the excavation of the channel through Subsection B of section 1 to a full depth of 30 feet at mean low water, with a width as great as can be formed with the funds available, not exceeding 600 feet, and to the construction of so much of the bulkhead required for the formation of the proposed island as is necessary to form a basin for the deposit of the material so excavated.

Under date of January 27, 1900, a contract was entered into with the Virginia Dredging Company, of Richmond, Va., for the removal of about 2,323,000 cubic yards of material to form a channel through the shoal in Subsection B, section 1 (near Reedy Island), to a depth of 30 feet at mean low water over a length of 20,500 feet, and to a width as great as could be formed with available funds, not exceeding 600 feet, together with the construction of about 11,700 linear feet of bulkhead to form a partly inclosed basin for the reception of dredged material. This contract was in accordance with the above-mentioned project.

Work under this contract was commenced on April 4, 1900. * * * On June 30, 1901, 8,140 linear feet of bulkhead had been completed and accepted, and an additional length of 2,200 feet had been partly constructed.

During the past fiscal year 3,557 linear feet of bulkhead was completed on September 12, 1901, making a total of 11,697 linear feet constructed under the contract. A description of this bulkhead is given in an appendix attached to this report.

The work of dredging was commenced on August 22, 1900, and up to the close of the fiscal year ending June 30, 1901, 1,004,338 cubic yards of material, scow measurement, had been removed under the contract, thereby forming a channel 30 feet deep at mean low water, about 18,900 feet long, with a width of from 50 to 300 feet, through a part of Dan Baker shoal.

An additional quantity of material, amounting to 85,650 cubic yards, dipper measurement, had been cast over against the inner face of the accepted bulkhead to form a backing for the structure.

During the past fiscal year an additional amount of 1,263,212 cubic yards was removed under the contract, making a total of 2,267,550 cubic yards. All operations under the contract were completed in December, 1901. As a result of the work done a channel 20,500 feet long, 30 feet deep at mean low water, and with an average width of 400 feet, was formed through the upper part of Baker shoal, and about one-third of the projected bulkhead for retaining dredged material was constructed.

Owing to the soft nature of the material which was dumped behind the bulkhead, the backing had a tendency to slide. A project was therefore submitted on June 18, 1901, and approved June 20, 1901, for the construction of buttresses of rough riprap stone at intervals along the outer face of the bulkhead, in order to give stability to the structure, at an estimated cost not to exceed $50,000.

During the past fiscal year a contract dated September 14, 1901, for this work was entered into with Messrs. Hughes Bros. & Bangs, of Syracuse, N. Y. Work under the contract was commenced in October, 1901, and completed December 17, 1901, 32,830 tons of stone (of 2,000 pounds) having been deposited in the construction of buttresses to give the bulkhead stability, and as riprap along the sheet piling where needed.

A project was submitted on June 4, and approved June 6, 1902, for the expenditure of about $100,000 for widening the channel already dredged through Baker shoal to the full width of 600 feet, with a depth of 30 feet. Contract for the work was entered into with the American Dredging Company, of Philadelphia, Pa., under date of June 26, 1902, but no work has yet been done. It is expected that all work provided for in the contract will be commenced and completed during the present working season.

The project approved September 29, 1899, also provided for the reservation of $18,400 from the appropriation of June 3, 1896, for the repair and maintenance of dikes. No expenditures have been made during the past fiscal year from this allotment.

It is proposed to expend available funds on the completion of work under existing contracts and on further work under the general project.

IMPROVEMENT OF PHILADELPHIA HARBOR.

Up to June 30, 1902, 39 wharves between Allegheny avenue and Moore street, on the Delaware River water front of the city of Philadelphia, had been extended to the new pier-head line, and between Pearl and Mickle streets, Camden, 5 wharves had been similarly extended to the New Jersey pier-head line.

During the past fiscal year 8 piers on the Philadelphia water front within the limits of the Philadelphia Harbor improvement were fully extended to the new line.

The city of Philadelphia has constructed a new bulkhead along the bulkhead line from Vine to South streets, which has permitted the widening of Delaware avenue at that locality to 150 feet. The work of widening Delaware avenue between Vine and Green streets has been authorized, but no appropriations have yet been made for commencing this work.

Detailed information with reference to these subjects is given in a letter dated June 28, 1902, from Mr. Theodore C. Knauff, secretary of the board of harbor commissioners, which he has kindly prepared at my request. This letter and its accompanying papers are appended hereto.

Under date of June 10, 1901, regulations for the use of the main ship channel of the Delaware River below Philadelphia were prescribed by the Secretary of War, under authority of section 4 of the river and harbor act of August 18, 1894.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended		$441,666.43
Amount appropriated by river and harbor act approved June 13, 1902.		600,000.00
		1,041,666.43
June 30, 1902, amount expended during fiscal year		134,200.48
July 1, 1902, balance unexpended		907,465.95
July 1, 1902, outstanding liabilities		130,660.78
July 1, 1902, balance available		776,805.17
July 1, 1902, amount covered by uncompleted contracts		96,000.00
Amount (estimated) required for completion of existing project		4,710,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$1,000,000.00	
For maintenance of improvement	100,000.00	
		1,100,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

Act of—		Act of—	
July 4, 1836	$15,000	August 5, 1886	$210,000
June 10, 1872	10,000	August 11, 1888	250,000
March 3, 1873	115,000	September 19, 1890	240,000
June 23, 1874	60,000	July 13, 1892	50,000
March 3, 1875	30,000	August 18, 1894	170,000
August 14, 1876	40,000	June 3, 1896	500,000
June 18, 1878	110,000	March 3, 1899	300,000
March 3, 1879	201,000	June 6, 1900	270,500
June 14, 1880	235,000	March 3, 1901	61,500
March 3, 1881	250,000	June 13, 1902	600,000
August 2, 1882	286,000		
July 5, 1884	200,000	Total	4,204,000

Total amount appropriated on present project to June 30, 1902 .... $1,100,000.00

EXPENDITURES.

Under previous projects	$2,967,681.83
Under present project	328,852.22
Total to June 30, 1902	3,296,534.05

CONTRACT IN FORCE, WITH NAMES OF CONTRACTORS, DATE OF APPROVAL, OF BEGINNING WORK, AND EXPIRATION.

With the American Dredging Company, of Philadelphia, Pa., dated June 26, 1902, for dredging in the Delaware River near Reedy Island and constructing retaining bank for dredged material. Work to be commenced on or before July 15, 1902, and completed on or before July 1, 1903.

COMMERCIAL STATISTICS.

The following statement concerning the foreign commerce of the Delaware River for the years ending December 31, 1900 and 1901, is compiled from reports of the board of trade, the commercial exchange, and the maritime exchange of the city of Philadelphia:

IMPORTS.

Articles.	1901.	rticles.	1901.
	Tons.		*Tons.*
Asphalt and asphalt blocks	24,412	Mineral water	694
Cement	4,756	Molasses	66,195
Chalk	44,213	Oil	3,281
Clay	54,449	Ores, metals, and manufactures of	1,258
Coal tar, and pitch of	1,213	Plants and seeds	6,547
Cork and cork wood	608	Plaster of paris	28,498
Cotton and cotton fabrics	4,137	Rags	2,147
Drugs and chemicals	89,673	Salt	17,688
Earthenware, china and stone ware	200	Silk, and manufactures of	127
Fertilizers	9,511	Stone, and manufactures of	1,575
Fruits	15,648	Sugar	363,052
Glass, and manufactures of	1,460	Sulphur, crude	12,036
Glue and glue stock	1,346	Sulphur, ore	67,755
Groceries and provisions	8,624	Tin	9,555
Hair, and manufactures of	1,083	Tobacco	817
Hemp, jute, flax, and their fabrics	31,151	Wines and liquors	2,044
Hides and skins	9,872	Wood pulp, paper, and manufactures of	9,514
Iron:			
Manufactures of	9,060	Wood, and manufactures of	4,124
Ore	332,651	Wool and wool fabrics	7,629
Pig	16,898	Miscellaneous	11,138
Scrap	2,168		
Leather, and manufactures of	181	Total	1,279,044
Live stock and fowls	56		

EXPORTS.

	Tons.		*Tons.*
Beef, pork, and products	69,857	Metals, other, and manufactures of	4,207
Bricks	16,715	Molasses	42,084
Bran, middlings, and mill feed	5,592	Oats and oatmeal	54,418
Cars and locomotives	1,497	Oil cake	50,468
Coal	687,274	Oils, lubricating	75,337
Corn and corn meal	444,958	Oil, other	4,650
Cotton and cotton fabrics	2,997	Paraffin	17,689
Drugs and chemicals	6,298	Petroleum, crude and refined	941,916
Fertilizers	261	Residuum	24,603
Flour	237,177	Rye	710
Fruit	626	Seeds	872
Glucose	17,588	Soap, tallow, and grease	7,609
Glue and glue stock	90	Stone, manufactured	13,821
Groceries and provisions	10,094	Tobacco	4,185
Gunpowder and explosives	161	Wheat	333,922
Hay	1,002	Wines and liquors	581
Hides, leather, and manufactures of	903	Wood pulp, paper, and manufactures of	537
Iron:			
Manufactured	27,316	Wood, and manufactures of	41,974
Pig	877	Miscellaneous	19,160
Scrap	24		
Live stock	13,534	Total	3,183,584

Passengers arriving from and departing for foreign countries by river, 1901.

Arrivals	17,259
Departures	7,072
Total	24,331

Comparative statement of tons and values of exports, imports, and revenue collected for the year 1901.

	Quantity.	Value.
	Tons.	
Exports	3,183,584	$79,324,344
Imports	1,279,044	51,365,142
Revenue	....	19,046,007

Foreign entrances and clearances.

Class.	Entered from foreign ports.				Cleared for foreign ports.				Total.	
	With cargo.		In ballast.		With cargo.		In ballast.			
	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.
American vessels:										
Steam	30	38,892	8	4,809	13	15,508	26	28,316	77	87,525
Sail	107	57,604	14	18,946	111	86,442	2	585	234	163,577
Foreign vessels:										
Steam	631	1,216,028	256	520,180	755	1,622,139	146	125,766	1,788	3,484,113
Sail	47	40,819	27	45,395	71	84,681	4	2,706	149	173,601
Total	815	1,353,343	305	589,330	950	1,808,770	178	157,373	2,248	3,908,816

The following statement concerning the domestic and coastwise commerce of the Delaware River for the year ending December 31, 1901, has been compiled from returns made to this office by shippers, consignees, and carriers:

Articles.	1901.	
	Quantity.	Value.
ARRIVALS.	*Tons.*	
Coal	493,761	$1,558,889
Cotton	5,854	1,133,380
Fertilizers	73,409	880,240
Iron:		
Manufactured	80,360	2,537,942
Pig	57,533	823,621
Lumber	961,743	12,661,662
Petroleum and products	41,279	583,871
Produce and fruit	86,795	2,859,820
Railroad ties	193,186	925,340
Sugar	44,467	3,519,010
Miscellaneous	4,521,410	551,308,760
Total	6,559,797	578,792,535
DEPARTURES.		
Coal	8,085,591	36,988,151
Cotton	2,684	630,410
Fertilizers	101,723	1,554,188
Iron:		
Manufactured	123,511	4,896,443
Pig	39,078	541,732
Lumber	77,959	1,016,488
Petroleum and products	334,749	5,707,746
Miscellaneous	4,302,804	446,010,130
Total	13,068,099	497,345,288

The apparent large decrease in the value of the miscellaneous domestic commerce for the year 1901, as compared with 1900, is due chiefly to the method of computation used. In 1900 shippers in only a few instances furnished values, and in other cases a value of $350 per ton was arbitrarily assumed for miscellaneous freight; in 1901 shippers themselves furnished the values. The amounts shown for the present year are believed, therefore, to be more reliable than those of the previous year.

Passengers arriving at and departing from Philadelphia by river, 1901.

Arrivals	1,444,452
Departures	1,459,235
Total	2,903,687

Domestic and coastwise arrivals and departures of vessels in cargo.

Class.	1901.	
	Arrivals.	Departures.
Steamers	[a]17,843	[a]18,745
Sailing vessels	4,934	[b]36,060
Canal boats and barges	[c]37,245	[d]48,292
Rafts	863	11
Total	60,885	105,108

[a] Excluding tugboats and ferryboats.
[b] Including 31,800 oyster boats.
[c] Including 12,923 railroad lighters.
[d] Including 12,727 railroad lighters.

SUMMARY.

Freight movement.

	1901.	
	Tons.	Value.
Foreign:		
Arrivals	1,279,044	$51,365,142
Departures	3,183,584	79,324,344
Domestic:		
Arrivals	6,559,997	578,792,535
Departures	13,068,099	497,345,288
Total	24,090,724	1,206,827,309

Movement of vessels, 1901.

	Arrivals.	Departures.
Foreign trade:		
Steam vessels	925	940
Sailing vessels	195	188
Domestic trade:		
Steam vessels	17,843	18,745
Sailing vessels	4,934	36,060
Canal boats and barges	37,245	48,292
Rafts	863	11
Total	62,005	104,236

LETTER FROM MR. THEO. C. KNAUFF, SECRETARY OF THE BOARD OF HARBOR COMMISSIONERS FOR THE CITY OF PHILADELPHIA, PA., WITH REFERENCE TO THE IMPROVEMENT BY THE CITY OF THE HARBOR OF PHILADELPHIA BY MEANS OF THE WIDENING OF DELAWARE AVENUE AND THE EXTENSION OF PIERS BY PRIVATE OWNERS, DURING THE FISCAL YEAR ENDING JUNE 30, 1902, WITH TWO INCLOSURES.

BOARD OF HARBOR COMMISSIONERS FOR THE CITY OF PHILADELPHIA,
Philadelphia, Pa., June 28, 1902.

DEAR SIR: I beg to acknowledge the receipt of your communication under date of June 24, 1902, in which you ask to be furnished with a concise statement regarding the progress made by the city of Philadelphia since June 30, 1901, on the reconstruction of the water front along the Delaware River and in the advancement of wharves to the new pierhead line, by the city and private owners.

Under the head of the improvement of the Delaware and Schuylkill rivers, I would state that the only harbor improvement has been done under a contract for improving the channels of both rivers, with the American Dredging Company, authorized by an ordinance of councils of July 27, 1901. The amount appropriated was $250,000, and the limit of the contract awarded was $238,000. The contract was awarded September 27, 1901, with ten months in which to finish the work. The contractor was notified to begin work on October 15, 1901. The work is progressing in a satisfactory manner, though it has been interfered with during the winter by severe weather. Fifty-three per cent of the work is completed, 386,009 cubic yards of material having been taken from the Delaware River along the Tinicum Island Range, 219,066 cubic yards from the Schuylkill River below Penrose Ferry Bridge, and 30,647 cubic yards from the same river above Penrose Ferry Bridge. All of this material has been deposited on the site of League Island Park east of Broad street by means of a canal 1 mile in length and a receiving basin, both built for the purpose. One hundred thousand three hundred and fifteen dollars and eight cents has been paid on account of the contract.

The mayor has made a report to councils in relation to the amount of damages to be paid property owners on Delaware avenue, between Vine and Green streets, for the widening of that avenue between the streets named, but no further action has yet been taken.

I inclose you herewith, marked "Exhibit A," copy of a letter from Mr. George S. Webster, chief engineer and surveyor of the city, giving all details in connection with these subjects.

The completion of the contract for the erection of the superstructure on the deck of the Race street pier, at a total cost of $102,523.85, has been the only work carried on along the water front of the city.

I also take pleasure in inclosing herewith, marked "Exhibit B," a communication from the secretary of the board of port wardens, containing a list of licenses granted by the board for the extension of piers in front of the city of Philadelphia, up to June 30, 1902.

Very truly,

THEO. C. KNAUFF, *Secretary.*

Capt. SPENCER COSBY, *Corps of Engineers.*

EXHIBIT A.

DEPARTMENT OF PUBLIC WORKS, BUREAU OF SURVEYS,
Philadelphia, Pa., June 25, 1902.

DEAR SIR: Answering your letter of the 17th instant, in which you ask for information relative to work performed by the city of Philadelphia since June 30, 1901, upon the improvement of the Delaware and Schuylkill rivers and the Philadelphia water front, I would state that the only harbor improvement has been carried on under contract with the American Dredging Company for improving the channels of the Delaware and Schuylkill rivers.

Councils by ordinance of July 27, 1901, appropriated the sum of $250,000 for this work; proposals were received September 17, 1901, and contract entered into September 27, 1901. The time to complete is limited to ten months. Limit of contract was $238,000. Contractor was notified to begin October 15, 1901. The work, which was interfered with by the severe weather of the past winter, is progressing in a satisfactory manner, 386,009 cubic yards of material having been removed from the Delaware River along the Tinicum Island Range; 219,066 cubic yards from the

Schuylkill River below Penrose Ferry Bridge, and 30,647 cubic yards above Penrose Ferry Bridge. Fifty-three per cent of the work completed.

The material excavated from both rivers has been deposited upon League Island Park, east of Broad street, a canal having been excavated over 1 mile in length in the back channel and a receiving basin having been built for the deposit of material prior to pumping over the banks. The total amount paid on account of this contract has been $100,315.08.

The only work that has been carried on upon the water front has been the completion of contract No. 17, for the construction of the superstructure on the deck of Race street pier, final estimate for which was drawn October 17, 1901, the total cost being $102,523.85.

In the matter of widening Delaware avenue between Vine and Green streets, I would state that after negotiating with all the property owners affected, with a view to determining the amount of damage suffered, the mayor has reported to councils the result of the negotiations.

Yours, truly,

G. S. Webster, *Chief Engineer.*

Mr. Theo. C. Knauff,
Secretary, Board of Harbor Commissioners.

Exhibit B.

Board of Port Wardens for the Port of Philadelphia, Pa.,
Philadelphia, Pa., June 30, 1902.

Dear Sir: In reply to your favor of the 17th instant, I send you below a list of the pier extensions licensed by the board of wardens since June 30, 1901:

July 10, 1901, Pennsylvania Railroad Company, to extend piers 49 and 50, north wharves.

October 7, 1901, Pennsylvania Railroad Company, to widen and extend pier 53, south wharves.

October 7, 1901, Pennsylvania Railroad Company, to widen and extend pier 55, south wharves; provided pier 54 be eliminated.

December 2, 1901, J. N. Pew, to build a wharf at Marcus Hook.

December 2, 1901, Pennsylvania Railroad Company, to extend piers Nos. 10 and 11, south wharves.

December 2, Pennsylvania Railroad Company, to extend pier 14, South Delaware avenue.

February 3, 1902, Clara E. Uhler, to extend pier 11, North wharves.

May 5, 1902, Pennsylvania Salt Manufacturing Company, to extend pier in front of property above Greenwich Point.

May 5, 1902, Fayette Manufacturing Company, to build pier at Chester.

I trust this information is what you desire, and if not I shall be pleased to be at your service at any time.

Very truly, yours,

Geo. F. Sproule, *Secretary.*

Mr. Theo. C. Knauff,
Secretary, Board of Harbor Commissioners.

DESCRIPTION OF BULKHEAD BUILT ON LOWER END OF BAKER AND STONY POINT SHOALS, DELAWARE RIVER, TO FORM A BASIN FOR THE RECEPTION OF DREDGED MATERIAL.

The report of the Board of Engineers, dated September 8, 1899, published in the Annual Report of the Chief of Engineers for 1900, page 1615, contains the approved project for the improvement of the Delaware River; it provides for the construction of an inclosed basin for retaining dredged material at Baker and Stony Point shoals, near Reedy Island, about 45 miles below Philadelphia. The location of the basin is shown on the map accompanying the report of the Board.

Baker and Stony Point shoals have a length approximately of 3 miles each, and are practically parallel to each other. In their original condition they were separated by a secondary channel having an average width of 1,000 feet between the 12-foot contours, and a low-water depth varying from 15 to 19 feet. The average low-water depths on the crests of the shoals were 10 and 8 feet.

As projected, the basin was designed to reduce the cross sections of the river, which were abnormally large at the locality, as well as to provide a place for the deposit of dredged material. A study of the conditions showed that a basin constructed to regulate uniformly the low-water widths would be so large as to be impracticable. It was therefore decided to have its sides follow the crests of Baker and Stony Point shoals, thus minimizing the cost of construction of the side walls, and affording ample capacity for the disposal of all material to be dredged from the river in the lower sections, estimated to amount to 19,127,000 cubic yards, scow measurement.

Data concerning the basin.

Area	acres	586
Length	feet	15,800
Maximum width	do	2,225
Average width	do	1,615
Maximum depth at low water of inclosed basin	do	19.2
Average depth at low water of inclosed basin	do	13
Height of retaining wall above low water	do	10
Estimated capacity of basin to 10 feet above low water, place measurement	cubic yards	21,700,000
Estimated capacity, scow measurement	do	27,125,000
Length of revetment for side and end walls	feet	32,400

The revetment as designed was to consist of sheet piling supported by pine and oak piles well braced, and backed by dredged material to be cast against it on the inside.

The part of the bulkhead constructed to date has a length of 11,697 linear feet, and forms the end and side walls of the lower third of the basin. It consists essentially of a two and a three row pile and sheet pile construction, as shown on the accompanying drawing,[a] the style of construction used depending on the depths of water in which it is built. The first piles were driven in April, 1900; on December 31, 1900, 3,810 linear feet of bulkhead, consisting of the entire lower end and parts of the side walls, had been finished. The entire work was completed on September 12, 1901. A great portion of the work has thus been exposed to the action of weather and ice for two winters, and all of it for one winter. A careful detailed examination of the whole structure made in May of this year showed it to be in excellent condition, the only repairs necessary being of a very minor nature, consisting chiefly of replacing a few bolts which had either sheared off or from which the nuts had become detached. Not a pile or sheet pile was broken.

As built, the structure consists, first of an outer row of oak piles, 7 to 8 inch tips and 12-inch butts, spaced from 4 to 4½ feet apart, center to center, cut off 12 feet above mean low water, and having a penetration of from 16 to 20 feet. In the two-row construction only a second row of yellow-pine piles was driven, spaced center to center, the same as the first row, the distance between the rows being 20 feet. In the three-row construction an additional row of piles was driven behind the second row as drag piles, the spacing between the three rows being respectively 15 and 10 feet. The sheet piling consists of single planks sharpened so as to drive close; they are of long-leaf Southern yellow pine, from 4 to 5 inches thick, driven to a penetration of from 8 to 10 feet, and cut off 10 feet above mean low water. The piles are connected by wales and cross braces of long-leaf pine, fastened by screw bolts, arranged as shown on the drawing,[a] and by wrought-iron tie rods 1¼ inches in diameter, tested for a tensile strength of 50,000 pounds per square inch. These rods are placed just above low water. On the second row of piles horizontal boards were nailed to a height of 6 feet above low water, to serve as anchors when material was cast against the inside of the bulkhead.

During the progress of construction it was found that the dredged material deposited behind the bulkhead remained in so fluid a condition that a constant heavy outward pressure was exerted against the structure. To counteract this, stone buttresses and riprap were placed on the outside, about 32,000 tons being used for the purpose. This effectually stiffened the structure, and it is now entirely rigid.

During the present and coming season it is proposed to deposit material within the part of the basin already constructed to the height of 10 feet above mean low water, thus utilizing its full capacity.

It is expected that the life of the bulkhead from 3 feet above low water will be about fifteen years. Below that height there should be little or no decay. Previous experience has shown that where fills behind bulkheads are brought above high water, the material soon consolidates, and although the upper part of the bulkhead gradually decays, the fill can easily be held in place. The stone placed outside the bulkhead can, if necessary, be used for this purpose.

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[a] Not printed.

H 26.

CONSTRUCTION OF IRON PIER IN DELAWARE BAY, NEAR LEWES, DELAWARE.

An account of this work is contained in the Annual Reports of the Chief of Engineers for 1896, page 920, and for 1900, page 1574.

During the past fiscal year no work has been done or liabilities incurred.

It is proposed to hold the sum of $820.60, which remains available, for maintenance and repairs as needed.

The funds now available are considered sufficient for present needs.

* * * * *

Money statement.

July 1, 1901, balance unexpended	$820.60
July 1, 1902, balance unexpended	820.60

APPROPRIATIONS.

Act of—		Act of—	
July 15, 1870	$225,000	June 14, 1880	$10,000
June 23, 1874	10,000	March 3, 1881	10,000
March 3, 1875	25,000	August 2, 1882	13,000
March 3, 1875	15,000	April 4, 1890	10,000
August 14, 1876	30,000	June 3, 1896	7,660
June 18, 1878	20,000		
March 3, 1879	10,500	Total	386,160

EXPENDITURES.

Total to June 30, 1902	$385,339.40

H 27.

IMPROVEMENT OF DELAWARE BREAKWATER, DELAWARE.

An account of this improvement is contained in the Annual Report of the Chief of Engineers for 1896, page 922; for 1897, page 1214; for 1898, page 1094; and for 1901, page 1323.

During the past fiscal year a survey of the breakwater harbor was made as part of a survey of the Harbor of Refuge. The map of this survey has not yet been completed.

The funds now available are considered sufficient for present needs, and it is proposed to hold the sum of $874.38, the available balance, for maintenance and repairs as needed.

The commercial statistics of the harbor at and in the vicinity of this breakwater are given in connection with the report on the Harbor of Refuge, Delaware Bay, Delaware.

* * * * * *

Money statement.

July 1, 1901, balance unexpended	$884.57
June 30, 1902, amount expended during fiscal year	9.93
July 1, 1902, balance unexpended	874.64
July 1, 1902, outstanding liabilities	.26
July 1, 1902, balance available	874.38

APPROPRIATIONS.

Act of—		Act of—	
May 7, 1822	$22,700.00	June 23, 1866	$107,910.00
May 23, 1828	250,000.00	March 2, 1867	109,493.70
April 23, 1830	162,000.00	August 2, 1882	125,000.00
March 2, 1831	208,000.00	July 5, 1884	75,000.00
July 3, 1832	270,000.00	August 5, 1886	56,250.00
March 3, 1833	270,000.00	August 11, 1888	100,000.00
June 28, 1834	270,000.00	September 19, 1890	80,000.00
March 3, 1835	100,000.00	July 13, 1892	50,000.00
July 2, 1836	100,000.00	August 18, 1894	50,000.00
July 4, 1836 (survey)	1,000.00	June 3, 1896	80,000.00
March 3, 1837	141,000.00		
July 7, 1838	150,000.00	Total	2,808,353.70
August 30, 1852	30,000.00		

* * * * * * *

EXPENDITURES.

Total to June 30, 1902	$2.807,479.06
Total under present project to June 30, 1902	615,375.36

H 28.

CONSTRUCTION OF HARBOR OF REFUGE, DELAWARE BAY, DELAWARE.

An account of this improvement is contained in the Annual Reports of the Chief of Engineers for 1897, page 1216, and for 1901, page 1325.

Under a contract with Messrs. Hughes Bros. & Bangs, dated February 15, 1897, 1,372,616 tons of stone were deposited in the breakwater to June 30, 1901.

During the past fiscal year under the same contract, 102,660 tons of stone were deposited in the work, and the breakwater was completed on December 11, 1901. The total quantity of stone deposited under the contract was 1,475,276 tons.

The contract above referred to provided for the complete construction of the breakwater, to be paid for as appropriations might from time to time be made by law. It required the placing of 125,000 tons of stone during the year ending December 31, 1897, as estimated by the engineer officer in charge, and for the continuance of the work as rapidly as might be required by the engineer officer, to the extent of placing 280,000 tons during any one calendar year, provided sufficient funds were available for payment therefor. The work was required to be commenced on or before May 1, 1897, and to be completed on or before December 31, 1901, unless prevented by lack of funds. The terms of the contract were satisfactorily complied with, and the breakwater was begun and completed within the required time.

The superstructure of the breakwater as completed has a length of 7,960 feet and the substructure a length of 8,040 feet measured on the low-water line.

A final report on this work has not yet been submitted.

In addition to the construction of the breakwater, the project for the harbor of refuge provides for the construction of a row of ice piers across the upper end of the harbor to protect it from ice descending the bay.

A project for the construction of ten of these piers was submitted on April 5, 1900, and approved by the Secretary of War on April 23, 1900.

Under date of September 7, 1900, a contract was entered into with Messrs. Hughes Bros. & Bangs, of Syracuse, N. Y., and approved October 2, 1900, for the construction of the ice piers. This contract provides for the complete execution of the work, to be paid for as appropriations may from time to time be made by law. It requires the placing of 64,500 tons of stone, the work to be commenced on or before November 3, 1900, and to be completed on or before December 31, 1901, unless prevented by lack of funds.

Work under the contract was commenced in October, 1900, and up to the close of the fiscal year ending June 30, 1901, 39,562 tons of stone had been placed in the ice piers, thereby partly constructing the substructures of all ten of the piers and partly constructing the superstructures of two of them.

During the past fiscal year under the contract 25,607 tons of stone were deposited in the work.

On June 30, 1902, all the ice piers had been partly constructed.

The funds on hand are considered sufficient for the completion of the work now projected.

During the past fiscal year from April to June, 1902, a survey of the breakwater harbor was in progress. The map of this survey has not yet been completed.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$438,420.91
June 30, 1902, amount expended during fiscal year	289,852.73
July 1, 1902, balance unexpended	148,568.18
July 1, 1902, outstanding liabilities	18,521.92
July 1, 1902, balance available	130,046.26
July 1, 1902, amount covered by uncompleted contracts	20,000.00

APPROPRIATIONS.

Act of—	
June 3, 1896	$5,000
June 4, 1897	394,334
July 1, 1898	800,000
March 3, 1899	377,000
June 6, 1900	$450,000
March 3, 1901	213,000
Total	2,239,334

EXPENDITURES.

Total to June 30, 1902	$2,090,765.82

CONTRACT IN FORCE, WITH NAME OF CONTRACTOR, DATE OF APPROVAL, OF BEGINNING WORK, AND EXPIRATION.

1. With Hughes Bros. & Bangs, of Syracuse, N. Y., dated September 7, 1900, and approved October 2, 1900, for complete execution of the work of constructing a row of ten ice piers, to be paid for as appropriations may be made from time to time by law. To be commenced on or before November 3, 1900, and completed on or before December 31, 1901, unless prevented by lack of funds.

COMMERCIAL STATISTICS.

During the year ending December 31, 1901, the following vessels called at Delaware Breakwater for the reasons given:

	Steamers.	Ships.	Barks.	Brigs.	Schooners.	Barges.	Total.
For orders	69	1	6	1	7	2	86
For harbor	46	2	10	4	1,172	282	1,516
In distress	1				6	6	13
Total	116	3	16	5	1,185	290	1,615

In addition to the above, a large number of craft under 30 tons have used the breakwater for harborage.

H 29.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

1. *Wreck of coal barge John Hevron in Arthur Kill, near Sewaren, N. J.*—On August 21, 1901, attention was called by the president of the board of commissioners of pilotage of New Jersey to a wreck in the Arthur Kill, near Sewaren, N. J., which proved to be the coal barge *John Hevron*. Being a menace to navigation steps were taken for its immediate removal. The wreck was reported August 22, and on August 24, 1901, an allotment of $210 was made to pay expenses in connection with its removal. The wreck was wholly removed on August 24, at a cost to the United States of $210, and report thereon submitted August 30, 1901.

2. *Wreck of unknown canal boat in Newark Bay, New Jersey.*—Information was received that a derelict canal boat was floating around in the channel of Newark Bay, New Jersey, in the vicinity of Shooters Island. Being a danger to navigation immediate steps were taken for its removal. The wreck was reported August 31, and on September 4, 1901, an allotment of $210 was made to pay expenses in connection with the removal of this wreck. The wreck was wholly removed on September 2, at a total cost to the United States of $210, and report thereon submitted September 12, 1901.

3. *Unknown wreck in Raritan River, near New Brunswick, N. J.*—Under date of March 13, 1902, the wreck was reported to this office by letter of Mr. D. C. Chase, president of the board of commissioners of pilotage of New Jersey. An examination showed that the wreck was located about 600 feet below the wharves at New Brunswick; that it con-

sisted of the bottom, sides, and ends of an old abandoned canal boat, name unknown; that there was nothing of value upon it, and that it was a dangerous obstruction to navigation. An estimate of $500 for its removal was submitted on March 31, 1902, and that sum was allotted by Department letter of April 2, 1902. Proposals for removing the wreck were received on April 5, and the bid of the Anderson-Murphy Company to do the work for the sum of $225 was accepted on April 9. The work of removing the wreck from the river was commenced on April 12 and completed on April 16, at a cost to the United States of $383.60. The wreck was finally disposed of on April 21, by breaking it up and placing it upon a wharf in South Brooklyn at the foot of Twenty-first street.

4. Wreck of coal barge B. L. Collar in Bronx River, New York.—Under date of June 12, 1902, this wreck was reported to this office by letter from the Bronx Company. An examination showed that the barge was sunk in the Bronx River at the sharp bend opposite the wharves of the Bronx Company, in such a manner as to prevent the passage of other barges except at extreme high tide. This barge had a cargo of coal consigned to the Bronx Company, which was removed and delivered by the underwriters, but the barge was allowed to remain in the river and no one can be found to claim ownership, although it is said that it is owned by Capt. W. J. Layman, who was on board until the cargo was taken out, but whose residence is now unknown to this office. There was nothing of value left upon the wreck. An estimate of $500 for its removal was submitted on June 21, 1902, and its removal was authorized and that sum was allotted by Department indorsement of June 25, 1902. Up to June 30, 1902, nothing had been done toward its removal.

* * * * * * *

5. Schooner Lottie K. Friend.—In September, 1895, the three-masted schooner *Lottie K. Friend*, with a cargo of coal, was sunk in Delaware Bay in collision with another vessel about 1¼ miles west from Ship John light. The wreck being considered a dangerous obstruction to navigation, its removal was recommended. Under date of February 8, 1897, a contract was entered into with Thomas Poynter and Elijah D. Register, of Lewes, Del., for the removal of the wreck for the sum of $1,100, the work to be completed on or before April 25, 1897. At the close of the fiscal year ending June 30, 1897, the removal of the wreck had been commenced, but had not been completed. During the fiscal year ending June 30, 1898, no additional work had been done toward the removal of the wreck under the above contract, and on June 16, 1898, it was recommended that the contract be annulled and the remaining wreckage be removed by dredging at some time when dredging operations were in progress in the neighborhood. This recommendation was approved on June 18, 1898. Since that time nothing has been done toward the removal of the wreck.

6. Dredge Potomac.—In December, 1900, the hydraulic dredge *Potomac* sank in the Delaware Breakwater Harbor as a result of leaks caused by a storm encountered while under tow from Alexandria, Va., to Atlantic City, N. J. The wreck lay in 17 feet of water at a point about one-fourth mile west of the iron pier, and, being considered a menace to vessels seeking a harbor, its removal was recommended. During September the owners of the sunken dredge had it completely removed from the harbor without expense to the United States. The allotment of $4,000, dated December 20, 1900, for the removal of the wreck, was withdrawn in September, 1901.

7. *Schooner Lavinia Campbell.*—During September, 1901, the three-masted schooner *Lavinia Campbell* sank in Delaware Bay as a result of collision with the schooner *C. F. Bronson.* The wreck lay on the western side of the main ship channel about one-half mile above Fourteen Foot Bank light-house, in 23 feet of water. An examination showed the hulk, which had been abandoned by its owners, to be a dangerous obstruction to passing vessels, and its removal was recommended September 24, 1901. Under date of October 28, 1901, an emergency contract was entered into with William H. Virden, of Lewes, Del., for its removal, for the sum of $2,200 (including inspection), and the work was entirely completed January 2, 1902.

8. *Canal boat H. C. Webster.*—In December, 1900, the canal boat *H. C. Webster* foundered in the upper Delaware River at a point about 800 feet above the mouth of Pennypack Creek and 500 feet off the Pennsylvania shore, in 22 feet of water. An examination of the wreck having shown it to be an obstruction to navigation, its removal was recommended September 26, 1901. Under date of October 29, 1901, an emergency contract was entered into with the River and Harbor Improvement Company of Camden, N. J., for the removal of this wreck, the sum agreed upon being $457.41 (including inspection), and the work was completed November 6, 1901.

9. *Schooner Lida Fowler.*—In October, 1901, the three-masted schooner Lida Fowler sunk on the east side of the main ship channel in Delaware Bay in 21 feet of water, about 1½ miles above Fourteen Foot Bank light-house, as a result of striking the wreck of the schooner Lavinia Campbell. Having been judged a dangerous menace to navigation and duly advertised as such, its removal was recommended October 25, 1901. An emergency contract was made with Napoleon B. Register and Nicholas H. Outten of Lewes, Del., dated January 14, 1902, who agreed to remove the wreck for the sum of $1,767.36 (with inspection). Under this contract work was commenced January 14, 1902, and prosecuted until February 2, when ice necessitated a suspension of operations until March 13, and the wreck was finally completely removed from the waterway May 26, 1902; the contractors having been granted an extension of their contract time.

10. *Chunker Beaver.*—In November, 1901, the bow compartment of the canal chunker *Beaver* sank in the Delaware River during a severe storm, alongside Harry Disston & Co.'s bulkhead at Tacony, about 200 feet above the Unruh street steamboat landing. Owing to its being in such close proximity to the wharf and in the path of vessels about to land there, the wreck was deemed an obstruction to navigation and its removal was recommended December 7, 1901. On December 6, the owner of the boat gave notice that he would abandon it, but before any steps were taken looking to its removal he again wrote requesting permission to remove it at his own expense. Authority to do this was granted under date of December 17, 1901, and the wreck was completely removed from the waterway, December 28, 1901, without expense to the United States, except for the cost of inspection, $47.88 covering this item.

H 30.

ESTABLISHMENT OF HARBOR LINES ALONG DELAWARE RIVER IN FRONT OF THE U. S. NAVY-YARD AT LEAGUE ISLAND, PA.

NAVY DEPARTMENT,
Washington, June 15, 1901.

SIR: I have the honor to inclose herewith a copy of a letter,[a] dated the 14th instant, from the acting chief of the Bureau of Yards and Docks, of this Department, relative to the proposed extension of Pier No. 2 at the League Island Navy-Yard, on the Delaware River front, requesting to be furnished with the position of the port wardens' line along the river front of the navy-yard, and that in case the present location of the port wardens' line does not permit the piers of 600 feet in length being built opposite the working part of the yard, such change in the position of the line be authorized as will permit this to be done, which is necessary for the safety of the vessels of the Navy.

In view of the statements of the Bureau, I have the honor to request that this matter be given early and favorable consideration.

Very respectfully,

JOHN D. LONG, *Secretary.*

The honorable the SECRETARY OF WAR.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
June 20, 1901.

Respectfully referred to Lieut. Col. C. W. Raymond, Corps of Engineers, for report.

To be returned.

By command of Brigadier-General Gillespie:

A. MACKENZIE,
Colonel, Corps of Engineers.

[Fifth indorsement.]

ENGINEER OFFICE, U. S. ARMY,
Philadelphia, Pa., August 7, 1901.

Respectfully returned to the Chief of Engineers, U. S. Army.

The authorities of the League Island Navy-Yard have been consulted in regard to such changes in the location of the harbor lines at this point as may be necessary to meet the purposes of the Navy Department, and the lines indicated on the accompanying tracing, a description of which is inclosed, represent a location which will provide for the piers 600 feet in length now contemplated and for the probable future requirements of this navy-yard.

These lines have been concurred in by Civil Engineer F. T. Chambers, United States Navy, in charge of engineering work at the League Island Navy-Yard.

On account of the narrowness of the Delaware River opposite the navy-yard as compared with its width immediately above and below, I am of the opinion that the construction of solid crib piers to the advanced pier-head line would probably injure the channel above this locality. The extensions of piers beyond the exisiting port warden's line should therefore be constructed of open pile work to a height of at least 2 feet above mean high water.

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[a] Not printed.

This report has been delayed by my absence on duty.

C. W. RAYMOND,
Lieut. Col., Corps of Engineers.

[Sixth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
August 10, 1901.

Respectfully returned to the Secretary of War.

The Navy Department requests to be furnished with the position of the port wardens' line along the Delaware River front of the League Island Navy-Yard, and in case the present location of the line does not permit the building of piers 600 feet in length opposite the working part of the yard that a change in the same be authorized.

The existing port wardens' line is shown on a blue print, herewith, which was obtained from the authorities of the city of Philadelphia, no line having been established at the locality by the War Department.

Colonel Raymond has considered the question of establishing a harbor line that will meet the purposes of the Navy Department, and, after conferring with the authorities of the League Island Navy-Yard, has prepared a tracing[a] showing a pierhead line for the westerly shore of the Delaware River in front of the navy-yard, which, in his opinion, will provide for the present and probable future requirements of this yard.

Attention is invited to his report in fifth indorsement hereon, and particularly to his statement that the construction of solid crib piers should not be advanced beyond the existing port wardens' line, and that the extensions of piers beyond said line should be constructed of open pile work to a height of at least 2 feet above mean high water.

I recommend that the papers be returned to the Secretary of the Navy for an expression of his views regarding the line proposed and, if satisfactory to him, I recommend that the line be approved.

A. MACKENZIE,
Acting Chief of Engineers.

[Seventh indorsement.]

WAR DEPARTMENT, *August 19, 1901.*

Respectfully returned to the honorable the Secretary of the Navy, inviting attention to the foregoing report of the Acting Chief of Engineers, and with request for an expression of his views regarding the line proposed, as therein suggested.

WM. CARY SANGER,
Acting Secretary of War.

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[a] Not printed.

[Eighth indorsement.]

NAVY DEPARTMENT, *August 21, 1901.*

Respectfully referred to the Bureau of Yards and Docks for report and recommendation, attention being invited to the sixth and seventh indorsements hereon, by the Acting Chief of Engineers, U. S. Army, and the Acting Secretary of War, respectively, forwarding a blue print showing the present port wardens' line, obtained from the authorities of the city of Philadelphia, and a tracing prepared by Lieut. Col. C. W. Raymond, Corps of Engineers, U. S. Army, showing a pierhead line for the westerly shore of the Delaware River in front of the navy-yard, which, in the latter's opinion, will provide for the present and probable future requirements of the navy-yard.

F. W. HACKETT,
Acting Secretary

[Ninth indorsement.]

BUREAU OF YARDS AND DOCKS,
NAVY DEPARTMENT,
August 28, 1901.

Respectfully returned to the Navy Department.

The line proposed would meet the needs of the naval service; and if adopted, this Bureau would meet the desire of the War Department that solid crib piers be not extended beyond the present port wardens' line.

It is recommended that the War Department be requested to adopt the line proposed.

MORDECAI T. ENDICOTT,
Chief of Bureau.

[Tenth indorsement.]

NAVY DEPARTMENT, *August 29, 1901.*

Respectfully returned to the honorable the Secretary of War, inviting attention to the ninth indorsement hereon of the Bureau of Yards and Docks, to the effect that the line proposed by the Acting Chief of Engineers, U. S. Army, in the sixth indorsement hereon, would meet the needs of the naval service; and if adopted, the Bureau would meet the desire of the War Department that solid crib piers be not extended beyond the present port wardens' line.

The recommendation of the chief of the Bureau of Yards and Docks, that the line proposed be adopted by the War Department, is approved.

F. W. HACKETT, *Acting Secretary.*

[Eleventh indorsement.]

WAR DEPARTMENT, *September 4, 1901.*

Approved as recommended by the Acting Chief of Engineers in the sixth indorsement hereon, the views of Colonel Raymond, as expressed in the fifth indorsement, being acceptable to the Navy Department.

G. L. GILLESPIE,
Acting Secretary of War.

DESCRIPTION OF THE PROPOSED PIERHEAD LINE FOR THE WESTERLY SHORE OF THE DELAWARE RIVER IN FRONT OF LEAGUE ISLAND NAVY-YARD, PHILADELPHIA, PA.

Beginning at a point A′, 5,846.521 feet from and perpendicular to the south side of Avenue 42 South, Philadelphia, at a point 12.527 feet easterly from the west side of Twenty-first street (this point in the pierhead line being connected with the pierhead line in the Schuylkill River, confirmed March 8, 1884, by a curve of 631.719 feet radius with a central angle of 85 degrees followed by a tangent 468.046 feet in length); thence from the point of beginning and at an angle of 70 degrees 55 minutes and 44 seconds with the perpendicular to Avenue 42 South, a distance of 4,119.570 feet to a point B′, 4,500.488 feet from and perpendicular to the south side of Avenue 42 South at a point 854.207 feet westerly from the west side of Eleventh street; thence making an angle of 78 degrees 53 minutes and 15 seconds with the perpendicular to Avenue 42 South, a distance of 3,135.564 feet to a point C′ 3,896.156 feet from and perpendicular to the south side of Avenue 42 South at a point 2.444 feet westerly from the west side of Sixth street; thence making an angle of 81 degrees 27 minutes and 39 seconds with the perpendicular to Avenue 42 South, a distance of 3,106.111 feet to a point E, 3,434.945 feet from and perpendicular to the south side of Avenue 42 South at a point 6.421 feet westerly from the east side of Swanson street, the latter point being coincident with point E in the port wardens line for this portion of the Philadelphia water front, authorized by ordinance of Philadelphia city councils, approved May 18, 1886.

APPENDIX I.

IMPROVEMENT OF ICE HARBOR AT MARCUSHOOK, PENNSYLVANIA, AND OF RIVERS AND HARBORS IN SOUTHERN NEW JERSEY AND IN DELAWARE—INLAND WATERWAY FROM CHINCOTEAGUE BAY TO DELAWARE BAY, VIRGINIA, MARYLAND, AND DELAWARE.

REPORT OF COL. JARED A. SMITH, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Ice Harbor at Marcushook, Pennsylvania.
2. Rancocas River, New Jersey.
3. Cooper Creek, New Jersey.
4. Mantua Creek, New Jersey.
5. Alloway Creek, New Jersey.
6. Goshen Creek, New Jersey.
7. Tuckerton Creek, New Jersey.
8. Raccoon Creek, New Jersey.
9. Wilmington Harbor, Delaware.
10. Appoquinimink River, Delaware.
11. Murderkill River, Delaware.
12. Mispillion River, Delaware.
13. Smyrna River, Delaware.
14. Inland waterway from Chincoteague Bay, Virginia, to Delaware Bay, at or near Lewes, Delaware.
15. Removing sunken vessels or craft obstructing or endangering navigation.

ENGINEER OFFICE, UNITED STATES ARMY,
Wilmington, Del., July 19, 1902.

GENERAL: I have the honor to inclose herewith the annual reports for the river and harbor improvement in this district for the fiscal year ending June 30, 1902. Lieut. Col. C. W. Raymond, Corps of Engineers, was in charge to October 1, 1901, and thereafter they were in my charge.

Very respectfully, your obedient servant,

JARED A. SMITH,
Colonel, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

I 1.

IMPROVEMENT OF ICE HARBOR AT MARCUSHOOK, PENNSYLVANIA.

A brief history of this improvement is contained in the Annual Report of the Chief of Engineers for 1896, page 918, and in Report of the Chief of Engineers for 1902.

* * * * * * *

A small map of the harbor accompanies this report.

Under date of November 13, 1901, a revocable license was granted by the Secretary of War to Mr. Joseph N. Pew, of Pittsburg, Pa., to erect and maintain a pier in the Delaware River at Marcushook, Pa.

The site of this pier extends from the shore outward over the two ice piers at the south end of the ice harbor. This does not interfere with the functions of the piers in protecting vessels from floating ice, and it will to some extent save expense for maintenance by the United States.

No work has been done during the last fiscal year.

The small amount incurred as liabilities is for travel to examine the shore piers.

Money statement.

July 1, 1901, balance unexpended	$1,715.72
July 1, 1902, balance unexpended	1,715.72
July 1, 1902, outstanding liabilities	1.52
July 1, 1902, balance available	1,714.20

APPROPRIATIONS.

Act of—		Act of—	
June 23, 1866	$5,000	August 5, 1886	$15,000
March 2, 1867	94,000	August 11, 1888	15,000
January 14, 1880	35,000	September 19, 1890	5,000
March 3, 1881	30,000		
August 2, 1882	15,000	Total	214,000

EXPENDITURES.

Total to June 30, 1902	$212,284.28

I 2.

IMPROVEMENT OF RANCOCAS RIVER, NEW JERSEY.

The Rancocas River is a small tributary of the Delaware River, its mouth being about 11 miles above the Pennsylvania Railroad terminal and ferry at Camden, N. J.

During the last fiscal year no work of improvement has been in progress on the main river or its branches.

A cursory examination was made in the latter part of June, 1902, to ascertain the present condition of the channels.

The river and harbor act of June 13, 1902, appropriated $3,000 for continuing improvement of the Lumberton branch. The project for expenditure of this amount has not yet been submitted to the Chief of Engineers.

Money statement.

July 1, 1901, balance unexpended	[a]$399.70
Amount appropriated by river and harbor act approved June 13, 1902	[b]3,000.00
July 1, 1902, balance unexpended	3,399.70

APPROPRIATIONS.

Below the forks.		
Act of—		
March 3, 1881	$10,000.00	
August 2, 1882	10,000.00	
September 19, 1890	10,000.00	
		$30,000.00
Mount Holly Branch.		
Act of—		
July 13, 1892	5,000.00	
August 18, 1894	3,000.00	
		8,000.00
Lumberton Branch.		
Act of—		
June 3, 1896	2,000.00	
March 3, 1899	2,000.00	
June 13, 1902	3,000.00	
		7,000.00
Total		45,000.00

EXPENDITURES.

Total to June 30, 1902	41,500.21
Carried to the surplus fund in July, 1890	100.09
Redeposited to credit of appropriation December 21, 1895	399.70

COMMERCIAL STATISTICS.

Vessels entering and leaving river for year ending December 31, 1901.

Kind of vessels.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steamers	468	163,800	468	163,800
Sailing vessels	75	7,050	75	7,050
Barges and canal boats	1,098	337,086	1,098	337,086
Tugs	850	17,850	850	17,850
Pleasure craft, etc	172	1,720	172	1,720
Total	2,663	527,506	2,663	527,506

Freight statement.

Articles.	Tons.	Value.
RECEIPTS.		
Coal	7,390	$33,255
Iron, pig	8,000	111,200
Lime	5,000	25,000
Lumber	2,300	56,000
Manure	27,300	34,125
Wood	600	2,400
Miscellaneous	13,200	4,060,000
Total	63,790	4,321,980

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[a] Pertains to Mount Holly Branch.

[b] Lumberton Branch.

Freight statement—Continued.

Articles.	Tons.	Value.
SHIPMENTS.		
Clay	7,840	$11,760
Fish	195	19,500
Produce	2,200	660,000
Sand and gravel	301,000	301,000
Miscellaneous	9,900	2,970,000
Total	321,135	3,962,260

I 3.

IMPROVEMENT OF COOPER CREEK, NEW JERSEY.

A brief history of this improvement is contained in Annual Reports of the Chief of Engineers for 1896, page 931; 1897, page 1123; 1898, page 1100, and 1899, page 1360.

During the last fiscal year no work has been done on the improvement.

Money statement.

July 1, 1901, balance unexpended	$8,823.90
July 1, 1902, balance unexpended	8,823.90

APPROPRIATION.

Act of June 3, 1896	$37,000.00

EXPENDITURES.

Rebuilding dike on Government reservation in Delaware River at Woodbury Creek	$2,500.00
Improvement of Cooper Creek, New Jersey	25,676.10
Total to June 30, 1901	28,176.10

I 4.

IMPROVEMENT OF MANTUA CREEK, NEW JERSEY.

An account of the improvement is contained in Annual Reports of the Chief of Engineers for 1899, page 1364; 1901, pages 241 and 1330–31, and in report for 1902.

No works of improvement have been carried on during the last fiscal year.

In making the cut-offs between phosphate works and Paulsboro the dredged material was placed upon the banks in such a way as to form an embankment or levee which prevented the water at high stages from overflowing the adjacent lands which were protected by levees along the banks of the old channel.

In the autumn of 1901 a break occurred in the levee on north side of first cut-off, and it was considered necessary to have it repaired to prevent injury to channel bank. The repairs were made at a very small expense.

Early in 1902 the embankment was again broken, and repairs were urged by the owners of lands as a protection from overflow.

An examination of the location leads to the conclusion that the conditions are not such that these embankments should be maintained as a preventive of injury to the adjacent lands by overflow, because the purchase and deed to land for the cut-offs included all injuries to adjacent lands by reason of cutting the new channel.

As it is not now apparent that the embankment is necessary for the maintenance of the channel, the latest break has not been repaired.

The estimated cost of the entire work was, under the present project, $145,030.

The channels thus far dredged have produced a notable change in tidal conditions, so that the average high water at head of navigation appears to be about 6 inches higher than formerly.

Whether the improvements to be obtained by dredging in old channels will be permanent is a question for which a definite answer must await further experience and study of the conditions.

The river and harbor act of June 13, 1902, appropriated $35,000 for continuing this improvement. It is proposed to expend this amount in cutting the channel through the swampy neck of the peninsula, to make a direct channel from the phosphate works to the Delaware River, and to construct the jetties.

Money statement.

July 1, 1901, balance unexpended	$152.27
Amount appropriated by river and harbor act approved June 13, 1902	35,000.00
	35,152.27
June 30, 1902, amount expended during fiscal year	24.61
July 1, 1902, balance unexpended	35,127.66
Amount (estimated) required for completion of existing project	85,030.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	85,030.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Act of August 2, 1882	$3,000.00
Act of March 3, 1899	25,000.00
Act of June 13, 1902	35,000.00
Total	63,000.00

EXPENDITURES.

For land required	8,000.00
Under projects	19,843.73
Total to June 30, 1902	27,843.73

COMMERCIAL STATISTICS.

Arrivals and departures of vessels for the year ending December 31, 1901.

Kind of vessels.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steamers	1,110	60,250	1,110	60,250
Sailing vessels	802	71,600	802	71,600
Barges and canal boats	825	98,750	825	98,750
Car floats	42	10,740	190	31,700
Total	2,779	241,340	2,927	262,300

Freight statement.

Articles.	Tons.	Value.
RECEIPTS.		
Bricks	600	$2,400
Chemicals	12,953	127,120
Coal	8,000	24,000
Fertilizer material	25,620	326,200
Hay	2,550	15,300
Lumber	5,000	100,000
Manure	42,000	63,000
Salt	150	2,500
Sand	1,250	1,250
Stone	3,000	12,000
Miscellaneous	8,000	1,175,000
Total	109,123	1,848,770
SHIPMENTS.		
Chemicals	960	4,200
Fertilizers (manufactured)	34,320	421,300
Manufactured goods	4,200	175,000
Sand and gravel	15,500	15,500
Truck, produce, and grain	35,000	840,000
Wood (cord)	390	1,560
Miscellaneous	3,210	160,500
Total	93,580	1,618,060

I 5.

IMPROVEMENT OF ALLOWAY CREEK, NEW JERSEY.

A condensed history of work on improvement of this creek is contained in Annual Reports of Chief of Engineers for 1896, page 928; 1899, page 158; and 1901, page 244.

During the last fiscal year no work of improvement has been done. The small amount of liabilities incurred are for expenses of an examination in June, 1902.

Of the works contemplated by approved project, about four-fifths have been accomplished. It is apparent, however, that such work is not permanent. During the last year the channel depths have diminished over the shoalest places from a depth of 5 feet in 1901 to but 3½ feet in 1902. This shows a very noticeable tendency to return to original conditions.

The entire amount appropriated by river and harbor act of June 13, 1902, will be required for restoration and maintenance of channels. To what extent the increased depths obtained from the improvements affects the rates of freight or the business of the community can not be now definitely stated.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902	$3,000.00
July 1, 1902, balance unexpended	3,000.00
July 1, 1902, outstanding liabilities	4.95
July 1, 1902, balance available	2,995.05
Amount (estimated) required for completion of existing project	4,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	4,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Act of—		Act of—	
September 19, 1890	$6,000	March 3, 1899	$3,000
July 13, 1892	3,000	June 13, 1902	3,000
August 18, 1894	3,000		
June 3, 1896	3,000	Total	21,000

EXPENDITURES.

Total to June 30, 1902	$18,000

COMMERCIAL STATISTICS.

Arrivals and departures of vessels for the year ending December 31, 1901.

Kind of vessel.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steamers	70	10,500	70	10,500
Sailing vessels	15	2,500	15	2,500
Barges and canal boats	60	12,500	60	12,500
Total	145	25,500	145	25,500

Freight statement.

Articles.	Tons.	Value.
Receipts:		
Coal	11,000	$33,000
Glass sand	12,000	24,000
Lumber	3,000	38,000
Oyster shells	3,500	7,000
Soda ash	500	10,000
Tin plate	2,000	170,000
Miscellaneous	12,500	212,000
Total	44,500	494,000
Shipments:		
Canned goods	10,000	600,000
Glassware	2,500	200,000
Grain	2,500	40,000
Produce	1,500	15,000
Ship timber	125	3,500
Miscellaneous	2,500	5,000
Total	19,125	863,500

I 6.

IMPROVEMENT OF GOSHEN CREEK, NEW JERSEY.

A summary of the history of this improvement is given in Annual Report of the Chief of Engineers for 1901, pages 245 and 246, and in Report of Chief of Engineers for 1902.

During the last fiscal year no work has been done upon this improvement.

In the latter part of June, 1902, an examination of the creek was made. The part of detached jetty which was originally constructed on the southerly side at mouth of creek was found to be considerably deteriorated. All the fascines and earthy material have been washed away. The outer portion of jetty over a length of 25 to 30 feet is in ruins; over a further length of 100 feet or more the sheet piling has been broken loose from waling strips.

The interval of 400 feet or more between the piling and shore was closed in year ending June 30, 1900, by a work of brush and stone. The top of this work is now about 2 feet below mean high water. Sand has drifted through and over the brush and stone until the mouth of the creek is practically closed at low water. The small jetty on opposite side of mouth of creek was cheaply made and serves very little purpose.

The small balance of funds now available is entirely insufficient to accomplish any real benefits to the navigation. Any possible benefits to commerce from further expenditures will undoubtedly be incommensurate with the expense. The creek is not considered worthy of further improvement.

Money statement.

July 1, 1901, balance unexpended	$841.72
June 30, 1902, amount expended during fiscal year	1.50
July 1, 1902, balance unexpended	840.22

APPROPRIATIONS.

Act of—	
July 13, 1892	$3,000.00
August 18, 1894	3,000.00
June 3, 1896	3,000.00
March 3, 1899	8,000.00
Total	17,000.00

EXPENDITURES.

Total to June 30, 1902	$16,159.78

I 7.

IMPROVEMENT OF TUCKERTON CREEK, NEW JERSEY.

A report of examination and survey of Tuckerton Creek, with a plan of improvement and estimated cost, is given on pages 1612–1615, Report of Chief of Engineers for 1900.

The river and harbor act of June 13, 1902, appropriated $12,000 for this improvement in accordance with the report submitted.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902	$12,000.00
July 1, 1902, balance unexpended	12,000.00
Amount (estimated) required for completion of existing project	49,380.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	49,380.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

I 8.

IMPROVEMENT OF RACCOON CREEK, NEW JERSEY.

A report of examination and survey of Raccoon Creek is given in Annual Report of Chief of Engineers for 1900, pages 1590 to 1598.

The project is for increasing channel depths by dredging to 7 feet at low water from the mouth to Springer's wharf, 5 miles; and thence 5 feet depth at low water to Swedesboro, 9¾ miles from the mouth. Estimated, cost $102,135.

The river and harbor act of June 13, 1902, appropriated $15,000 for improving the creek in accordance with the report which had been submitted. The project is therefore limited to improvement of channels by dredging.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902	$15,000.00
July 1, 1902, balance unexpended	15,000.00
Amount (estimated) required for completion of existing project	87,135.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	87,135.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

I 9.

IMPROVEMENT OF WILMINGTON HARBOR, DELAWARE.

An outlined history of this improvement is contained in the Annual Report of the Chief of Engineers for 1901, pages 246 to 249.

The project for a channel depth of 21 feet at low water adopted in 1896 was completed under the provisions of the river and harbor act of March 3, 1899, and June 6, 1900.

The total amount expended on this project has been $440,248.06.

The channel of 21 feet depth dredged previous to June 30, 1901, filled again very rapidly and to such an extent as to show very little difference in one year between previous and subsequent conditions. The extreme length of the channel of 21 feet was about 4 miles.

June 30, 1902, the depth at the upper end of dredged channel was 10 to 12 feet; from that point to the mouth of the Brandywine River only 12 feet could be carried throughout, and thence to the mouth of the river the shoalest depths in mid-channel were only 15 feet, although in places they were considerably more.

A cursory examination of the channel from the pulp works to Newport at the end of the fiscal year showed mid-channel depths not less than 7 feet, which indicate that no filling of mid-channel has taken place since it was dredged to 7 feet depth. The bordering lands are generally low, and in many places levees or other barriers have, in years past, been constructed to regulate or prevent the overflow of large areas where the ground is low. These barriers are now broken away in many places, so that the tidal basin above has been considerably increased; the banks of channel have been considerably eroded; a large amount of material has thus been carried from the barriers and channel into the deeper channel below.

It is probable that these conditions have operated as a very important factor in filling the channel below.

No work of importance has been in progress during the last fiscal year. Work under contract was completed August 12, 1901. This completed the project.

The total amount expended on the improvement from 1836 to June 30, 1902, was $842,444.84.

Turned back into Treasury, surplus fund, $2,411.22.

Money statement.

July 1, 1901, balance unexpended	$65, 193. 13
Amount appropriated by river and harbor act approved June 13, 1902	50, 000. 00
Taken up on account of erroneous payments	56. 66
	115, 249. 79
June 30, 1902, amount expended during fiscal year	54, 595. 19
July 1, 1902, balance unexpended	60, 654. 60
July 1, 1902, outstanding liabilities	8, 022. 50
July 1, 1902, balance available	52, 632. 10
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement by means of contraction works, in addition to the balance unexpended July 1, 1902 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	100, 000. 00

APPROPRIATIONS.

Act of—	
July 14, 1836	$15, 000. 00
March 3, 1837	8, 000. 00
July 7, 1838	9, 356. 00
July 11, 1870	15, 000. 00
June 10, 1872	10, 000. 00
March 3, 1873	6, 000. 00
June 23, 1874	6, 000. 00
March 3, 1875	10, 000. 00
August 14, 1876	16, 000. 00
June 18, 1878	7, 000. 00
March 3, 1879	3, 500. 00
June 14, 1880	10, 000. 00
March 3, 1881	50, 000. 00
August 2, 1882	50, 000. 00
July 5, 1884	25, 000. 00
August 5, 1886	18, 750. 00

Act of—	
August 11, 1888	$30, 000. 00
September 19, 1890	30, 000. 00
July 13, 1892	40, 000. 00
August 18, 1894	25, 000. 00
June 3, 1896	20, 000. 00
July 1, 1898	205, 846. 00
March 3, 1899	45, 000. 00
June 6, 1900	200, 000. 00
June 13, 1902	50, 000. 00
Total	905, 452. 00
Received on account of overpayments	56. 66
	905, 508. 66

EXPENDITURES.

Total to June 30, 1902	$842,442.84
Carried to surplus fund	2,411.22
	844,854.06
Total on present project	440,248.06

COMMERCIAL STATISTICS.

The following statement of the foreign and domestic commerce of the harbor of Wilmington, Del., for the year ending December 31, 1901, has been compiled from returns made to this office by the board of trade, Wilmington, Del.:

Vessel movement.

Class.	Arrivals.	Departures.
Steamers	1,628	1,628
Sailing vessels	188	199
Canal boats and barges	1,680	1,671
Total	3,496	3,498

Freight statement.

Articles.	Tons.	Value.
RECEIPTS.		
Cement and sand	67,792	$95,691
Coal	25,400	76,873
Iron and steel	76,941	1,421,939
Lumber	31,476	242,345
Miscellaneous	186,368	13,852,120
Total	387,977	15,688,968
SHIPMENTS.		
Coal	25,400	76,873
Fertilizers	21,000	131,628
Machinery	29,487	272,434
Powder	2,890	138,725
Stone (quarry)	100,090	240,862
Miscellaneous	186,368	13,852,120
Total	365,235	14,712,642

I 10.

IMPROVEMENT OF APPOQUINIMINK RIVER, DELAWARE.

A condensed history of this improvement is contained in the Annual Report of the Chief of Engineers for 1900, page 211, and Report for 1901, pages 250–251.

During the last fiscal year no work has been done on this improvement.

Money statement.

July 1, 1901, balance unexpended	$87.93
July 1, 1902, balance unexpended	87.93
Amount appropriated by river and harbor act approved June 13, 1902, for Appoquinimink, Murderkill, and Mispillion	15,000.00
Amount (estimated) required for completion of existing project	14,963.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	14,963.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Act of—	
September 19, 1890	$5,000
July 13, 1892	5,000
August 18, 1894	5,000
June 3, 1896	5,000
March 3, 1899	5,000
Total	25,000

(Appropriation of $15,000, act of June 13, 1902, for Appoquinimink, Murderkill, and Mispillion combined.)

EXPENDITURES.

Total to June 30, 1902	$24,912.07

COMMERCIAL STATISTICS.

Arrivals and departures of vessels for the year ending December 31, 1901.

Kind of vessels.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steamers	215	32,250	215	32,250
Sailing vessels	35	2,450	35	2,450
Barges and canal boats	25	5,000	25	5,000
Total	275	39,700	275	39,000

Freight statement.

Articles.	Tons.	Value.
RECEIPTS.		
Coal	3,050	$16,775
Fertilizers	4,525	66,875
Potatoes	200	6,000
General merchandise	4,450	354,750
Total	12,225	444,400
SHIPMENTS.		
Canned goods	1,575	126,000
Fish	250	25,000
Fruit	1,325	54,000
Grain	7,250	217,500
Live stock	1,425	114,000
Poultry	425	68,000
General merchandise	600	45,000
Total	12,850	649,500

I 11.

IMPROVEMENT OF MURDERKILL RIVER, DELAWARE.

A brief history of work on this improvement is given in the Annual report of the Chief of Engineers for 1900, pages 213–214, and in the report for 1901, pages 254–255.

No work has been done on this improvement in the last fiscal year.

Money statement.

July 1, 1901, balance unexpended	$139.22
July 1, 1902, balance unexpended	139.22
Amount appropriated by river and harbor act approved June 13, 1902, for Appoquinimink, Murderkill, and Mispillion	15,000.00
Amount (estimated) required for completion of existing project	27,764.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	27,764.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Act of—

July 13, 1892	$7,000
August 18, 1894	6,500
June 3, 1896	6,500
March 3, 1899	5,000
Total	25,000

(Appropriation of $15,000 for Appoquinimink, Murderkill, and Mispillion combined, act of June 13, 1902.)

EXPENDITURES.

Total to June 30, 1902	[a]$24,860.78

COMMERCIAL STATISTICS.

Arrivals and departures of vessels for the year ending December 31, 1901.

Kind of vessels.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steamers	136	16,320	136	16,320
Sailing vessels	20	800	20	800
Canal boats and barges	32	4,800	32	4,800
Total	188	21,920	188	21,920

[a] Of this amount $1,500 was expended in removing shoal at mouth of St. Jones River.

Freight statement.

Articles.	Tons.	Value.
Receipts:		
Coal	3,000	$10,150
Horses and mules	300	22,500
Phosphate	2,500	45,000
Tin and solder	350	31,600
General merchandise	600	120,000
Total	6,750	229,250
Shipments:		
Canned goods	2,500	160,000
Fruits and vegetables	500	90,000
Grain	2,650	45,500
Horses and mules	100	10,000
Poultry, live and dressed	300	60,000
General merchandise	500	100,000
Total	6,550	465,500

I 12.

IMPROVEMENT OF MISPILLION RIVER, DELAWARE.

A brief history of work on this improvement is given in the Annual Report of the Chief of Engineers for 1900, page 215, and in 1901, pages 258 and 259.

During the last fiscal year no work has been done on the project.

Money statement.

July 1, 1901, balance unexpended		$193.25
June 30, 1902, amount expended during fiscal year	$3.62	
June 30, 1902, redeposited to credit of appropriation for emergencies in river and harbor work, act June 6, 1900	27.68	
		31.30
July 1, 1902, balance unexpended		161.95
Amount appropriated by river and harbor act approved June 13, 1902, for Mispillion, Appoquinimink, and Murderkill		15,000.00

APPROPRIATIONS.

Act of—		
March 3, 1879	$3,000	
June 14, 1880	4,000	
March 3, 1881	3,500	
August 2, 1882	3,000	
August 11, 1888	3,500	
		$17,000
Project of 1891.		
Act of—		
July 13, 1892	12,000	
August 18, 1894	10,000	
March 3, 1899	2,500	
June 6, 1900 (allotment)	1,050	
		25,550
Total		42,550

(Appropriation of $15,000, act of June 13, 1902, for Appoquinimink, Murderkill, and Mispillion, combined.)

EXPENDITURES.

Total to June 30, 1902	$42, 360. 37
Returned to Treasury to credit of appropriation for emergencies in rivers and harbors	27. 68
	42, 388. 05

COMMERCIAL STATISTICS.

Arrivals and departures of vessels for the year ending December 31, 1901.

Kind of vessels.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steamers	126	23, 562	126	23, 562
Sailing vessels	45	51, 975	45	51, 975
Barges and canal boats	6	720	6	720
Total	177	76, 257	177	76, 257

Freight statement.

Articles.	Tons.	Value.
Receipts:		
Ales, wines, and liquors	334	$33, 494
Bricks	800	2, 400
Building materials	4, 260	97, 800
Coal	5, 560	26, 738
Dry goods and notions	2, 154	558, 860
Fertilizers	9, 200	184, 000
Fruits and vegetables	1, 630	38, 141
Groceries and provisions	8, 910	339, 400
Hardware and machinery	2, 076	124, 611
Live stock and poultry	1, 020	40, 800
Lumber and supplies for shipbuilding	2, 400	36, 000
General merchandise	20, 902	729, 080
Total	59, 246	2, 211, 324
Shipments:		
Canned goods	14, 560	144, 000
Flour and feed	9, 482	452, 512
Fruits and vegetables	7, 063	88, 000
Grain	4, 554	105, 000
Piling and railroad ties	16, 153	18, 460
Salt hay	2, 200	8, 400
Total	54, 012	816, 372

I 13.

IMPROVEMENT ON SMYRNA RIVER, DELAWARE.

A brief history of work under projects for improving this river is given in the Annual Reports of Chief of Engineers for 1900, p. 212, and 1901, p. 252.

No work of improvement has been in progress during the last fiscal year.

Money statement.

July 1, 1901, balance unexpended	$252.46
Amount appropriated by river and harbor act approved June 13, 1902	15,000.00
July 1, 1902, balance unexpended	15,252.46
Amount (estimated) required for completion of existing project	4,365.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	4,365.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Project of 1878.		
Act of—		
June 14, 1880	$5,000	
March 3, 1881	3,000	
August 2, 1882	2,000	
		$10,000
Project of 1887.		
Act of—		
August 11, 1888	10,000	
September 19, 1890	5,000	
July 13, 1892	3,000	
August 18, 1894	5,000	
June 3, 1896	5,000	
March 3, 1899	5,000	
June 13, 1902	15,000	
		48,000
Total		58,000

EXPENDITURES.

Total to June 30, 1902	$42,747.54

I 14.

IMPROVEMENT OF INLAND WATERWAY FROM CHINCOTEAGUE BAY, VIRGINIA, TO DELAWARE BAY, AT OR NEAR LEWES, DELAWARE.

A history of the projects for improvement and of work accomplished is included in Annual Reports of Chief of Engineers for 1885, pages 891 to 914; 1892, pages 956 to 965; and 1900, page 217.

Under date of February 14, 1902, proposals were invited by public advertisement for dredging to restore channel depths in the canal at Rehoboth and as far south in Rehoboth Bay, Indian Bay, and Whites Creek as can be done with available funds; also to protect the mouth of canal at entrance to Rehoboth Bay with small jetties.

Proposals were opened March 17, 1902, and a contract was awarded to Messrs. Lea & Smith, of New York, who were the lowest bidders.

Work under the contract should have been commenced May 1, but the contractors appear to have been delayed by adverse circumstances, so that no work had been accomplished at the end of the fiscal year.

It will require the entire amount of appropriation of June 3, 1896, to restore channels previously dredged and to secure the maintenance of channel at mouth of canal in Rehoboth Bay.

Under the expectation that the amount would be applied to continuance of work under the project, it has heretofore been deducted from amount still required for completion of project. Such deduction is therefore necessarily canceled and the amount required for completion is restored to $181,250.

This estimate, in addition to construction of bridges, represents dredging at 15 cents per cubic yard below high water and 20 cents per cubic yard above that grade. Dredging under contract in 1895 was at a rate of 24.4 cents per cubic yard for all grades. In 1902 the price for dredging to restore former channels is 35 cents for hard and 33 cents per cubic yard for soft material; nearly all material is hard under the classification. The estimate covers nothing for protection of the end of canal at its junction with tidal water at Lewes, nor does it cover the award of $37,343.58 made to the Delaware, Maryland and Virginia Railroad Company for right of way at the crossing near Rehoboth. The canal can not be operated as a through route to points on the Delaware Bay without crossing the railroad and having some kind of a lock at or near Lewes, in addition to piers or other harbor protection to maintain depths and shield the entrance from seas on the bay.

The waterway is not so situated as to make probable any extensive shipments at either of its terminals, and at least three-fourths of its entire length is through the middle portions of very shallow bays, so far from shore as to make landings impracticable. The shipping points would, therefore, for the district as a whole, be several times as far from the producing districts—except for oysters, crabs, and fish—as the stations on the railroad.

In winter the through route would not be available and in hot weather perishable products, both of land and bays, would probably be shipped by express in order to reach the markets in good condition.

Lumber can not be shipped to advantage on very small vessels, nor from inconvenient shipping points. The canal as now planned can only be used by launches or very small boats. To increase the dimensions and provide shipping points along the bays would increase the cost to an amount far beyond any reasonable expectation of benefits which would accrue to commerce directly or indirectly. The work is not therefore considered as being worthy of further improvement.

The expenditures in the last fiscal year have been for the necessary examinations, advertising, and other work preparatory to commencing work under contract.

Money statement.

July 1, 1901, balance unexpended	$26,044.94
June 30, 1902, amount expended during fiscal year	716.82
July 1, 1902, balance unexpended	25,328.12
July 1, 1902, outstanding liabilities	188.06
July 1, 1902, balance available	25,140.06
July 1, 1902, amount covered by uncompleted contracts	22,500.00
Amount (estimated) required for completion of existing project	[a]181,250.00

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[a] Exclusive of $37,343.58, award for right of way through Delaware, Maryland and Virginia Railroad.

APPROPRIATIONS.

Act of—		Act of—	
August 5, 1886	$18,750	August 18, 1894	$25,000
August 11, 1888	50,000	June 3, 1896	25,000
September 19, 1890	50,000		
July 13, 1892	25,000	Total	193,750

EXPENDITURES.

Total to June 30, 1902	$168,421.88

ABSTRACT OF CONTRACTS PERTAINING TO RIVER AND HARBOR IMPROVEMENTS UNDER DIRECTION OF COL. JARED A. SMITH, CORPS OF ENGINEERS, IN FORCE JUNE 30, 1902.

Name of contractor and work: Samuel H. Lea and Julian C. Smith, New York, N. Y., for dredging and jetty construction on inland waterway from Chincoteague Bay, Virginia, to Delaware Bay at or near Lewes, Del.

Rates: For dredging and jetty construction, viz: Brush mattresses, in place, $1.55 per square yard; small stone, in place, $3.15 per ton of 2,000 pounds; large stone, placed, $3.30 per ton of 2,000 pounds; excavating, removing, and depositing sand or hard clay, 35 cents per cubic yard, scow measurement; excavating, removing, and depositing mud and soil, 33 cents per cubic yard, scow measurement.

Date of approval: April 16, 1902.

Time of beginning work: May 1, 1902.

Time of expiration: October 31, 1902.

I 15.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

[In charge of Lieut. Col. C. W. Raymond, Corps of Engineers, to October 1, 1901, and thereafter unde Col. Jared A. Smith, Corps of Engineers.]

Canal boat Zeus, lying in Smyrna River, Delaware.—At the close of the last fiscal year operations were in progress for the removal of this wreck, and these were completed on July 18, 1901. The total cost, including inspection and incidental expenses, was $221.02.

Steamship Ranald, foundered in the Atlantic Ocean, off the New Jersey coast, about 3 miles south of Absecon light.—At the close of last fiscal year an allotment of $15,000 had been made, and proposals for removing the wreck were opened August 12, 1901, that of Van Sant & Boehm, of Atlantic City, N. J., who offered to do the work for $7,416, being the lowest. * * *

From a subsequent examination the hull appeared to be intact and settling in the sand, the least depths found over it being 16 feet on the bow, 33 feet amidship, and 28 feet on the stern. Its direction and distance from Absecon light-house on that date were S. 8° W., nearly 3 miles; from Absecon Inlet bell buoy, S. 26° W., nearly 1⅝ miles; from The Elephant, E. 2° N., nearly 4⅝ miles. Its location is about one-half mile inside the line from shoals outside of Absecon Inlet to the head lands of Cape May, and therefore not in the course generally taken by coastwise vessels, and to the class of small vessels which visit points along the shore it is not an obstruction. No further action toward the removal of the wreck was therefore taken by the United States, and the funds on hand available for the work were returned to the Treasury to the credit of the appropriation. The amount expended was $144.79.

Lighter No. 33, lying in Schuylkill River, Pennsylvania.—This vessel, while moored close to the bank of the river, on July 4, 1901, sank at the lower outer corner of the Continental Iron Company's wharf at Breeze Point, Philadelphia. A contract, dated August 16, 1901, for the removal of the wreck was made with Alvin R. Morrison, the lowest bidder, for the sum of $500, and the work of removal was completed August 26, 1901, the entire cost being $524.17.

Barge Sunflower, in Chester River, Pennsylvania.—This vessel was sunk in August, 1901, in from 9 to 13 feet of water, about 225 feet below the Seventh Street Bridge at Chester, forming a dangerous obstruction to its navigation. Contract, dated January 9, 1902, was made with John J. Williams, at $425, the work to be commenced within 10 days, and completed within 30 days from the date of commencement. The wreck was raised and removed and the contract completed on April 7, 1902. The total cost, including inspection, etc., was $494.16.

Schooner Irene A. B. Crawford, lying in Dennis Ceeek, New Jersey.—This wreck was not considered such an obstruction to navigation as is contemplated by law, and its removal at the expense of the United States was therefore not recommended. The cost of its examination was $21.21.

Schooner Melvina, in Mahon River, Delaware.—The wreck lying head downstream, in about 6 feet of water, near the right bank of the main fork of the Mahon River, just below its confluence with Little Hog Pen Creek, at a bend 3 miles from Delaware Bay, formed a dangerous obstruction to navigation. Contract, dated April 30, 1902, was entered into with Howard McGonigal, of Little Creek, Del., the lowest bidder, at $240. The work of removal was completed May 14, 1902. The total cost, including inspection, etc., was $314.50.

Canal boat Peter A. Rogers, in Schuylkill River, Pennsylvania.—As this wreck seriously interfered with navigation its immediate removal was authorized under section 20 of the river and harbor act of March 3, 1899. Two open-market offers for the work were received, and award made to the River and Harbor Improvement Company, at $945, the lowest bid received, on April 26, 1902. Operations for the removal of the wreck were begun the same day, and the work was completed April 30. The total cost, including inspection, etc., was $1,000.

Canal boat Ida May, in Rancocas River, New Jersey.—Proposals for the removal of this wreck were opened June 30, 1902, the lowest being that of Louis H. Darling, of Philadelphia, who offered to remove the wreck for $289. At the close of the fiscal year the bids were under consideration.

Examinations of wrecks off Green Run Inlet Life-Saving Station and of wreck in Little Creek, Delaware, have been ordered, for which the sum of $70 has been allotted.

APPENDIX J.

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN MARYLAND TRIBUTARY TO CHESAPEAKE BAY, AND OF BROAD CREEK AND NANTICOKE RIVERS, DELAWARE AND MARYLAND.

REPORT OF COL. PETER C. HAINS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Elk River, Maryland.
2. Susquehanna River above and below Havre de Grace, Maryland.
3. Patapsco River and Channel to Baltimore, Maryland.
4. Channel to Curtis Bay, in Patapsco River, Baltimore Harbor, Maryland.
5. Harbor at Southwest Baltimore (Spring Garden), Maryland.
6. Rockhall Harbor and Inner Harbor at Rockhall, Maryland.
7. Queenstown Harbor, Maryland.
8. Claiborne Harbor, Maryland.
9. Cambridge Harbor, Maryland.
10. Chester River, Maryland, from Crumpton to Jones Landing.
11. Choptank River, Maryland.
12. Warwick River, Maryland.
13. Pocomoke River, Maryland, below Snow Hill.
14. Wicomico River, Maryland.
15. Tyaskin Creek, Maryland.
16. La Trappe River, Maryland.
17. Nanticoke River, Delaware and Maryland.
18. Broad Creek River, Delaware.
19. Manokin River, Maryland.
20. Removing sunken vessels or craft obstructing or endangering navigation.

United States Engineer Office,
Baltimore, Md., July 19, 1902.

General. I have the honor to forward herewith the annual reports for the fiscal year ended June 30, 1902, pertaining to the river and harbor * * * works in my charge.

* * * * * * *

Very respectfully, your obedient servant,

Peter C. Hains,
Colonel, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

J 1.

IMPROVEMENT OF ELK RIVER, MARYLAND.

No work was done during the fiscal year.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902	$16,665.00
July 1, 1902, balance unexpended	16,665.00

AMOUNTS APPROPRIATED.

By act approved—		By act approved—	
June 23, 1874	$5,000	September 19, 1890	$10,000
March 3, 1875	5,000	July 13, 1892	5,000
June 14, 1880	10,000	June 13, 1902	16,665
March 3, 1881	5,000		
By act passed August 2, 1882	6,500	Total	63,165

COMMERCIAL STATISTICS FOR CALENDAR YEAR 1901.

Receipts and shipments.

Class.	Tons.	Value.
Receipts:		
Wood	16,600	$53,950
Fertilizers	1,102	17,632
Total	17,702	71,582
Shipments:		
Fertilizers	2,735	43,760
Total receipts and shipments	20,437	115,342

Vessels trading in Elk River, Maryland.

Class.	Number.	Aggregate tonnage.	Draft.	Trips.
			Feet.	
Schooners, barges, etc	163	61,125	8½	Irregularly.
Tugboats	2	....	7½	As required.

Two boat yards are engaged in building barges.

J 2.

IMPROVEMENT OF SUSQUEHANNA RIVER ABOVE AND BELOW HAVRE DE GRACE, MARYLAND.

No work has been done since 1889.

Money statement.

July 1, 1901, balance unexpended	$9,734.05
Amount appropriated by river and harbor act approved June 13, 1902	10,000.00
July 1, 1902, balance unexpended	19,734.05
Amount (estimated) required for completion of existing project	84,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	20,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

AMOUNTS APPROPRIATED.

By act approved—		
August 30, 1852	$10,000	
June 23, 1866	26,400	
July 25, 1868 (allotment)	5,000	
April 10, 1869 (allotment)	990	
July 11, 1870	12,000	
June 14, 1880	28,000	
March 3, 1881	15,000	
		$97,390
By act passed August 2, 1882	25,000	
By act approved—		
July 5, 1884	20,000	
August 5 1886	6,000	
By act of August 11, 1888	10,000	
By act approved—		
September 19, 1890	4,000	
July 13, 1892	4,000	
1879, allotment from general appropriation for examinations and surveys	500	
By act of—		
August 18, 1894	4,000	
June 13, 1902	10,000	
		83,500
Aggregate		180,890

* * * * * * *

J 3.

IMPROVEMENT OF PATAPSCO RIVER AND CHANNEL TO BALTIMORE, MARYLAND.

During the whole fiscal year dredging was in progress under the continuing contract, with an intermission from December 21, 1901, to March 17, 1902, when there was a suspension on account of ice and rough weather. Four dredges were engaged in the operations, three of the clam shell and one of the elevator type, the latter working on the parts where hard material is encountered. In June this dredge found a ledge of rock in the Cut-off channel and was engaged five days in removing it. The quantity amounted to 2,469 cubic yards. The quantity of material removed under the contract during the fiscal year amounts to 3,415,924 cubic yards. The total quantity removed under the contract is 9,444,199 cubic yards. The contractor has exceeded the rate of progress required by the contract by 2,444,199 cubic yards, and it is anticipated that the contract and the project will be completed in the autumn of 1902. A project for a channel 35 feet in depth and 600 or 1,000 feet wide from Baltimore to the sea has been submitted, and if no appropriation is made at the next session of Congress for that channel the sum of $50,000 will be required for the maintenance of the 30-foot channel.

Money statement.

July 1, 1901, balance unexpended	$566,268.76
Amount appropriated by river and harbor act approved June 13, 1902	25,000.00
	591,268.76
June 30, 1902, amount expended during fiscal year	319,375.52
July 1, 1902, balance unexpended	271,893.24
July 1, 1902, outstanding liabilities	3,100.00
July 1, 1902, balance available	268,793.24
July 1, 1902, amount covered by uncompleted contracts	155,365.11
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	50,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

The following are the amounts and dates of appropriations for improving harbor at Baltimore, Md., including Patapsco River:

August 30, 1852	$20,000	March 3, 1881	$150,000
August 15, 1856	100,000	August 2, 1882	450,000
June 28, 1864	20,000	July 5, 1884	250,000
June 23, 1866	5,200	August 5, 1886	150,000
March 3, 1867	75,000	August 11, 1888	300,000
July 25, 1868	17,000	September 19, 1890	340,000
April 10, 1869	26,730	March 3, 1891	151,200
July 11, 1870	42,900	August 5, 1892	208,000
March 3, 1871	50,000	August 18, 1894	50,000
June 10, 1872	100,000	June 3, 1896	400,000
March 3, 1873	200,000	June 3, 1896	50,000
June 23, 1874	75,000	March 3, 1899	200,000
March 3, 1875	75,000	June 6, 1900	324,648
August 14, 1876	75,000	March 3, 1901	475,352
June 18, 1878	75,000	June 13, 1902	25,000
March 3, 1879	160,000		
June 14, 1880	100,000	Total	4,741,030

CONTRACT IN FORCE.

Continuous contract with Simon Hess, at 8.33 cents per cubic yard, approved July 5, 1899, commenced September 12, 1899, and expires June 30, 1903.

COMMERCIAL STATISTICS FOR FISCAL YEAR ENDING JUNE 30, 1902.

* * * * * * *

Imports.

In American vessels in 1902:	
Sailing	$2,154,263
Steam	211,160
In foreign vessels in 1902:	
Sailing	80,802
Steam	20,459,370
In cars overland	40,984
Total	22,946,579

* * * * * * *

Domestic exports.

In American vessels in 1902:	
Sailing	$656,226
Steam	3,864
In foreign vessels in 1902:	
Sailing	104,237
Steam	79,738,748
Total	80,503,075

Recapitulation.

In American vessels in 1902	660,090
In foreign vessels in 1902	79,842,985

Principal articles exported.

	Tons.		Tons.
Cattle	23,838	Beef products	4,992
Grain	593,990	Pork products	15,558
Flour	274,446	Lard	33,778
Coal	378,527	Oleomargarine	7,691
Copper	36,876	Starch	1,544
Cotton, unmanufactured	29,684	Rosin	30,249
Glucose	3,146	Tobacco	29,285
Iron and steel	68,356	Oils	134,792
Oil cake	34,021	Wood, and manufactures of	171,404

Amount of duties collected in 1902	$3,394,858.47
Miscellaneous customs receipts in 1902	122,393.55
Total receipts in 1902	3,517,252.02

* * * * * * *

Duties on merchandise in bond in 1902	208,710.13

Summary of duties collected in 1902.

Imports and miscellaneous customs receipts	$3,517,252.02
Merchandise in bond	208,710.13
Merchandise transported with appraisement	18,573.18
Total	3,744,535.33

* * * * * * *

Tonnage movement, 1901-2.

	Entered.		Cleared.	
	Number.	Tons.	Number.	Tons.
Foreign trade	815	1,405,607	739	1,352,873
Coastwise trade	1,484	2,110,781	2,187	2,660,609

Alien passengers, 1901-2.

Males	32,629
Females	7,727
Total	40,356

Vessels built, 1901-2.

	Number.	Tons.	Value.
Steam	14	20,409	$1,960,900
Sail	4	598	31,500
Total	18	21,007	1,992,400

Steamship lines.

	Number of ships.	Tonnage.	Destination.
Hamburg-American	19	84,459	Hamburg.
Atlantic Transport	7	22,107	London.
Lord Line	12	30,405	Belfast and Dublin.
Earn Line	8	12,341	Mediterranean ports.
North German Lloyds	17	69,745	Bremen.
Di Giorgia Importing and Steamship Co	6	2,517	Cuba and Jamaica.
United Fruit Co	6	3,639	Jamaica.
Johnston Line	7	31, 39	Liverpool.
Blue Cross	1	2,979	Havre.
Donaldson	11	30,794	Glasgow.
Puritan	4	9,060	Antwerp.
Neptune	8	17,089	Rotterdam.
Elder	4	18,300	Mediterranean ports.

The following lines have reduced the number of vessels:

Hamburg-American	5
Atlantic Transport	2
Lord Line	1
United Fruit Company	4
Line discontinued: Empire Line	7
Total loss	19

The following lines have added to the number of vessels:

Earn Line	1
Johnston Line	2
Donaldson Line	4
North German Lloyd	8
Di Giorgia Importing and Steamship Company	4
New Line: Elder Line	4
Total gain	23

The foreign tonnage movement at this port shows a falling off, which, however, in view of the general depression of the foreign carrying trade, was not unexpected, due largely to shortage in our cereal crops. The coastwise trade shows an increase.

There were built and documented in this collection district during the year 18 steam and sail vessels, aggregating a gross tonnage of 21,007 tons and valued at $1,992,400. At the yards of the Maryland Steel Company two mammoth 11,000-ton steel steamships for the Atlantic Transport Company are on the ways. There are now 13 established lines of steamships trading at this port, representing 331,695 tons and an estimated carrying capacity of 497,542 tons cargo.

J 4.

IMPROVEMENT OF CHANNEL TO CURTIS BAY, IN PATAPSCO RIVER, BALTIMORE HARBOR, MARYLAND.

There were no operations during the fiscal year.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902	$50,000.00
July 1, 1902, balance unexpended	50,000.00

Amount (estimated) required for completion of existing project	146,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	146,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

The following are the amounts and dates of appropriations for improving channel to Curtis Bay, in Patapsco River, Baltimore Harbor, Maryland.

July 13, 1892	$28,000
August 13, 1894	12,000
June 13, 1902	50,000
Total	90,000

* * * * * * *

J 5.

IMPROVEMENT OF HARBOR OF SOUTHWEST BALTIMORE (SPRING GARDEN), MARYLAND.

Nothing has ever been done.

Money statement.

July 1, 1901, balance unexpended	$5,000.00
Amount appropriated by river and harbor act approved June 13, 1902	88,000.00
July 1, 1902, balance unexpended	93,000.00
Amount (estimated) required for completion of existing project	221,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	221,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

The following are the amounts and dates of appropriations for improving harbor of Southwest Baltimore (Spring Garden), Md.:

June 23, 1896	$5,000
June 13, 1902	88,000
Total	93,000

COMMERCIAL STATISTICS.

The statistics of the port of Baltimore include this harbor.

J 6.

IMPROVEMENT OF ROCKHALL HARBOR AND INNER HARBOR AT ROCKHALL, MARYLAND.

No dredging was done in the fiscal year.

Money statement.

Allotment from amount appropriated by river and harbor act approved June 13, 1902	$12,000.00
July 1, 1902, balance unexpended	12,000.00

The following are the amounts and dates of appropriations for improving Rockhall Harbor and inner harbor at Rockhall, Md.:

June 3, 1896	$16,600.00
Allotment from act June 13, 1902	12,000.00
Total	28,600.00

COMMERCIAL STATISTICS FOR CALENDAR YEAR 1901.

ROCKHALL, KENT COUNTY, MD., *June —, 1902.*

SIR: The industries and commerce at Rockhall have grown rapidly during the past two years. A careful examination into the facts leads me to the following conclusion:

The population of the town is about 2,600; number of stores, 32; lumber yards, 2; saw and planing mill, 1; also 1 small planing mill; blacksmiths and wheelwrights, 4; coal yard, 1; canning establishments, 2 (not running at present).

About 50 vessels, sloops and schooners, of from 5 to 50 tons make Rockhall their headquarters. * * * At the present two steamboats, the *Gratitude* and *B. S. Ford*, touch at Rockhall, each making the round trip daily. The *B. S. Ford* carries excursions between Baltimore and Rockhall and Chester River. A sailing packet for the transportation of freight also runs regularly between Rockhall and Baltimore. * * * The estimated value of oysters, fish, and crabs shipped from Rockhall is $116,500. General merchandise shipped to Rockhall to supply stores is estimated at $200,800; lumber, $28,000; bricks, $1,875; fertilizers, $15,400; coal, $17,850.

The country back of Rockhall is a rich agricultural country and sends a large quantity of grain, fruit, and products to Baltimore by the way of Rockhall. All the different articles are transported by water, the nearest railroad station, Chestertown, being about 11 miles by the county road.

* * * * * * *

Yours, very respectfully,

JOSEPH DOWNEY.

Brig. Gen. P. C. HAINS,
United States Army.

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J 7.

IMPROVEMENT OF QUEENSTOWN HARBOR, MARYLAND.

No dredging was done in the fiscal year.

Money statement.

July 1, 1901, balance unexpended	$385.18
Allotment from amount appropriated by river and harbor act approved June 13, 1902	12,000.00
	12,385.18
June 30, 1902, amount expended during fiscal year	385.18
July 1, 1902, balance unexpended	12,000.00

AMOUNTS APPROPRIATED.

By act approved—	
March 3, 1871	$5,000
June 10, 1872	6,000
March 3, 1879	3,000
June 3, 1896	5,000
By allotment from act of June 13, 1902	12,000
Total	31,000

COMMERCIAL STATISTICS FOR CALENDAR YEAR 1901.

Receipts and shipments.

Class.	Tons.	Value.
Receipts:		
Bricks, flour, lumber, etc	1,349	$24,416
Fruit, grain, cattle, etc	380	49,939
General merchandise	5,506	324,074
Total	7,235	399,439
Shipments:		
Carriages, leather, lumber, etc	87	16,021
Fruit, grain, poultry, etc	2,856	151,425
General merchandise	1,150	69,000
Total	4,093	236,446
Total receipts and shipments	11,328	635,873

J 8.

IMPROVEMENT OF CLAIBORNE HARBOR, MARYLAND.

No work has ever been done by the United States.

Money statement.

Allotment from amount appropriated by river and harbor act approved June 13, 1902	**$15,000.00**
July 1, 1902, balance unexpended	**15,000.00**

AMOUNT APPROPRIATED.

Allotment from act of June 13, 1902	**$15,000.00**

J 9.

IMPROVEMENT OF CAMBRIDGE HARBOR, MARYLAND.

No work was done in the fiscal year.

Money statement.

Allotment from amount appropriated by river and harbor act approved June 13, 1902	**$3,000.00**
July 1, 1902, balance unexpended	**3,000.00**

AMOUNTS APPROPRIATED.

By act approved—	
March 3, 1871	**$10,000**
June 10, 1872	**10,000**
March 3, 1873	**5,000**
June 18, 1878	**5,000**
March 3, 1879	**2,500**
By act of August 11, 1888	**5,000**

By act approved—	
September 19, 1890	$5,000
July 13, 1892	7,737
Allotment from act of June 13, 1902	3,000
Total	53,237

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J 10.

IMPROVEMENT OF CHESTER RIVER, MARYLAND, FROM CRUMPTON TO JONES LANDING.

No dredging was done during the fiscal year.

Money statement.

July 1, 1901, balance unexpended	$266.79
Allotment from amount appropriated by river and harbor act approved June 13, 1902	5,402.00
	5,668.79
June 30, 1902, amount expended during fiscal year	46.05
July 1, 1902, balance unexpended	5,622.74

AMOUNTS APPROPRIATED.

By act approved—	
September 19, 1890	$5,000
July 13, 1892	3,000
By act of August 18, 1894	1,500
By act of June 3, 1896	1,500
By act of March 3, 1899	3,200
By allotment from act of June 13, 1902	5,402
Total	19,602

COMMERCIAL STATISTICS FOR CALENDAR YEAR 1901.

Receipts and shipments.

	Tons.
Receipts:	
Phosphates	1,967
Lumber	467
Live stock	1,086
Oil	210
Miscellaneous	13,246
Total	16,976
Shipments:	
Grain	9,300
Fruits and tomatoes	9,027
Oysters, crabs, and fish	2,251
Live stock	543
Canned goods	348
Miscellaneous	3,243
Total	24,757
Total receipts and shipments	41,733

J 11.

IMPROVEMENT OF CHOPTANK RIVER, MARYLAND.

No dredging was done in the fiscal year.

Money statement.

July 1, 1901, balance unexpended	$108.93
Allotment from amount appropriated by river and harbor act approved June 13, 1902	3,000,00
	3,108.93
June 30, 1902, amount expended during fiscal year	10.45
July 1, 1902, balance unexpended	3,098.48

AMOUNTS APPROPRIATED.

By act approved—	
June 14, 1880	$5,000
March 3, 1881	5,000
By act passed August 2, 1882	5,000
By act approved—	
July 5, 1884	5,000
August 5, 1886	10,000
By act of August 11, 1888	7,500
By act approved—	
September 19, 1890	7,500
By act approved—	
July 13, 1892	$3,000
By act of August 18, 1894	2,000
By act of June 3, 1896	2,000
By act approved March 3, 1899	8,000
Allotment from act of June 13, 1902	3,000
Total	63,000

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J 12.

IMPROVEMENT OF WARWICK RIVER, MARYLAND.

No dredging was done in the fiscal year.

Money statement.

July 1, 1901, balance unexpended	$12.39
Allotment from amount appropriated by river and harbor act approved June 13, 1902	4,000.00
	4,012.39
June 30, 1902, amount expended during fiscal year	12.39
July 1, 1902, balance unexpended	4,000.00

AMOUNTS APPROPRIATED.

By act approved June 14, 1880		$3,000
By act approved March 3, 1881		3,000
Total		6,000
By act approved July 13, 1892	$6,000	
By act of August 18, 1894	2,000	
By act of June 3, 1896	2,000	
By act of March 3, 1899	2,000	
Allotment from act of June 13, 1902	4,000	
Total on present project		16,000
Aggregate		22,000

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J 13.

IMPROVEMENT OF POCOMOKE RIVER, MARYLAND, BELOW SNOW HILL.

No dredging was done in the fiscal year.

Money statement.

July 1, 1901, balance unexpended	$149.08
Allotment from amount appropriated by river and harbor act approved June 13, 1902	4,800.00
	4,940.08
June 30, 1902, amount expended during fiscal year	149.08
July 1, 1902, balance unexpended	4,800.00

AMOUNTS APPROPRIATED.

By act approved—		
June 18, 1878		$10,000
March 3, 1879		2,500
August 5, 1886		8,000
Total		20,500
By act of June 3, 1896	$5,000	
By act approved March 3, 1899	3,000	
Allotment from act June 13, 1902	4,800	
Total on present project		12,800
Aggregate		33,300

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J 14.

IMPROVEMENT OF WICOMICO RIVER, MARYLAND.

No dredging was done in the fiscal year.

Money statement.

July 1, 1901, balance unexpended	$2.00
Allotment from amount appropriated by river and harbor act approved June 13, 1902	6,798.00
July 1, 1902, balance unexpended	6,800.00

AMOUNTS APPROPRIATED.

By act of—		
June 10, 1872	$5,000	
March 3, 1873	5,000	
June 28, 1874	5,000	
March 3, 1875	5,000	
August 14, 1876	5,000	
June 18, 1878	5,000	
March 3, 1879	3,000	
June 14, 1880	5,000	
March 3, 1881	2,000	
July 5, 1884	10,000	
		$50,000
September 19, 1890	10,000	
July 13, 1892	6,500	
August 18, 1894	3,000	
June 3, 1896	3,700	
Allotment from act June 13, 1902	6,798	
Total on present project		29,998
Aggregate		79,998

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J 15.

IMPROVEMENT OF TYASKIN CREEK, MARYLAND.

No work has ever been done by the United States.

Money statement.

Allotment from amount appropriated by river and harbor act approved June 13, 1902	$8,000.00
July 1, 1902, balance unexpended	8,000.00

AMOUNT APPROPRIATED.

Allotment from act of June 13, 1902	$8,000

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J 16.

IMPROVEMENT OF LA TRAPPE RIVER, MARYLAND.

No dredging was done in the fiscal year.

Money statement.

July 1, 1901, balance unexpended	$36.13
July 1, 1902, balance unexpended	36.13
Amount (estimated) required for completion of existing project	2,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	2,500.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

AMOUNTS APPROPRIATED.

By act approved—	
July 13, 1892	$2,500.00
August 18, 1894	4,750.00
Total	7,250.00

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J 17.

IMPROVEMENT OF NANTICOKE RIVER, DELAWARE AND MARYLAND.

No dredging was done in the fiscal year.

Money statement.

July 1, 1901, balance unexpended	$852.86
June 30, 1902, amount expended during fiscal year	66.36
July 1, 1902, balance unexpended	786.50

AMOUNTS APPROPRIATED.

By act of June 3, 1896	$3,000
By act approved March 3, 1899	3,000
Total	6,000

(See note to appropriations for Broad Creek River, Delaware.)

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J 18.

IMPROVEMENT OF BROAD CREEK RIVER, DELAWARE.

No dredging was done in the fiscal year.

Money statement.

July 1, 1901, balance unexpended	$385.75
June 30, 1902, amount expended during fiscal year	10.95
July 1, 1902, balance unexpended	374.80

AMOUNTS APPROPRIATED.

By act approved—	
June 14, 1880	$5,000
March 3, 1881	10,000
By act passed August 2, 1882	5,000
By act approved August 5, 1886	10,000
By act of August 11, 1888	5,000
Total	35,000
By act approved July 13, 1892	$5,000
By act of August 18, 1894	[a]5,000
By act of June 3, 1896	5,000
By act approved March 3, 1899	5,000
Total, present project	20,000
Aggregate	55,000

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J 19.

IMPROVEMENT OF MANOKIN RIVER, MARYLAND.

No dredging was done in the fiscal year.

Money statement.

July 1, 1901, balance unexpended		$237.95
June 30, 1902, amount expended during fiscal year		122.92
July 1, 1902, balance unexpended		115.03
Amount (estimated) required for completion of existing project		7,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$7,500.00	
For maintenance of improvement	4,000.00	
		11,500.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

AMOUNTS APPROPRIATED.

By act approved—	
September 19, 1890	$7,500
July 13, 1892	7,500
Act of August 18, 1894	4,000
Act of June 3, 1896	[b]4,000
Act of March 3, 1899	1,500
Total	24,500

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[a] This appropriaton was applied to removing bar on Nanticoke River, under the terms of the appropriation.

[b] Of this amount $2,000 is for work in the upper river not covered by project.

J 20.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

Schooner Eldridge, sloop Ephraim Lyttee, sloop Maggie, and hull of an old pile driver.—These craft were wrecked and abandoned in Cambridge Harbor, Maryland, in 1898 and 1899, and were obstructions to navigation. They all lay south of the drawbridge. The *Eldridge* is 75 feet long, 20 feet beam, and lay in 7 feet of water; the *Ephraim Lyttee* is 45 feet long, 18 feet beam, and lay in 7 feet of water; the *Maggie* is of the same dimensions and laid in 4½ feet of water, and the hull of the old pile driver is 20 feet long, 12 feet beam, and lay in 6 feet of water. The wrecks were lifted bodily, chained to a lighter, towed to Hambrook Cove, Choptank River, and deposited along the shore inside the hook and behind the bar, in 4½ feet of water. The work was commenced July 8, 1901, and completed on the 12th. The cost of the work was $633.

Barge Milgendutt.—This vessel sank in the upper part of the Chesapeake Bay July 7, 1901, while in tow of a tug. It was 110 feet in length and 19 feet beam, and lay in 24 feet of water. The wreck was removed by the owner and towed to Baltimore August 12, 1901, without expense to the Government.

Schooner Ida E. Comley.—This vessel sank in the Chesapeake Bay off Sandy Point light-house in September, 1901, and lay with 40 feet of water over her deck, but her three masts showing above water. She was 133.8 feet in length, 23.8 feet beam, and 7.6 feet depth, and had a cargo of 340 tons of bituminous coal. The wreck was broken up by explosions of dynamite and the débris above the bed of the bay removed, unobstructed navigation being restored October 5, 1901. The services of the U. S. steam tender *Sentinel*, a submarine diver and outfit, and employees of the district were used in the operations. The cost of the operations was $500.

The total amount expended in the removal of wrecks during the fiscal year ending June 30, 1902, is $1,133.

APPENDIX K.

IMPROVEMENT OF POTOMAC RIVER AND ITS TRIBUTARIES; OF JAMES RIVER AND OF HARBOR AT MILFORD HAVEN, VIRGINIA, AND OF CERTAIN RIVERS IN MARYLAND AND VIRGINIA ON THE WESTERN SHORE OF CHESAPEAKE BAY; PROTECTION OF JAMESTOWN ISLAND, VIRGINIA.

REPORT OF LIEUT. COL. CHAS. J. ALLEN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Potomac River, at Washington, District of Columbia.
2. Potomac River, below Washington, District of Columbia.
3. Anacostia River, District of Columbia.
4. Breton Bay and Patuxent River, Maryland.
5. York River, Virginia.
6. Occoquan Creek, Virginia.
7. Lower Machodoc Creek, Virginia.
8. Nomini Creek, Virginia.
9. Rappahannock River, Virginia.
10. Urbana Creek, Virginia.
11. Harbor at Milford Haven, Virginia.
12. Mattaponi River, Virginia.
13. Pamunkey River, Virginia.
14. James River, Virginia.
15. Protection of Jamestown Island, Virginia.
16. Removing sunken vessels or craft obstructing or endangering navigation.

United States Engineer Office,
Washington, D. C., July 19, 1902.

General: I have the honor to forward herewith my annual report for the fiscal year ended June 30, 1902, for river and harbor works in my charge, * * * .

Very respectfully, your obedient servant,

Chas. J. Allen,
Lieut. Col., Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

K 1.

IMPROVEMENT OF POTOMAC RIVER AT WASHINGTON, DISTRICT OF COLUMBIA.

WORK OF THE FISCAL YEAR ENDED JUNE 30, 1902.

Dredging in the Virginia Channel above Long Bridge under contract with the Atlantic, Gulf and Pacific Company was in progress at the close of the preceding fiscal year and was continued until September 28, 1901, when the limit of dredging under the contract was reached. Excellent progress was made on this work, and in September, 1901, 177,000 cubic yards of material were excavated and deposited by the dredge working night and day, which is the largest monthly amount of work that has ever been done with a single dredge on this improvement.

Three hundred and ninety thousand six hundred and fifty-seven cubic yards of material were dredged from the Virginia Channel above Long Bridge and deposited upon Potomac Park during the fiscal year, making in all 565,575 cubic yards dredged from this channel, or a total of 672,820 cubic yards excavated and deposited under the contract with the Atlantic, Gulf and Pacific Company. As a result of the work done under this contract there existed in September, 1901, a channel 400 feet wide and 20 feet deep through the bar at the entrance to the Washington channel, and a channel had been obtained through the entire length of the bar in the Virginia Channel above Long Bridge of 20 feet depth and with widths as follows: For a distance of 4,800 feet from the lower end of the bar, 400 feet; thence for 1,200 feet, narrowing uniformly to 270 feet; thence with a width of 270 feet for 2,100 feet, or to the upper end of the bar.

The material dredged from the channels was deposited on Potomac Park so as to materially raise the grade of several low portions of large area.

During the greater part of February, 1902, the river was covered with ice from 4 to 8 inches in thickness and navigation was largely suspended. On the 25th of that month, the river having risen from heavy rains and melting snow, the ice commenced to move out, and by the end of the month it had all disappeared from the channels, but the freshet was still increasing and attained its maximum height March 2. The water reached the following elevations above mean low tide: Twelve feet at the Aqueduct Bridge, 8.7 feet at Easbys Point, and 7.9 feet at the Long Bridge, being the highest water since the great freshet of 1889. The ice had been well broken up in front of and below Washington by tugs, employed under direction of the city, and no serious damage resulted either from the moving ice or freshet, though the water was extremely muddy for two weeks or more and some shoaling and narrowing of the dredged channels occurred. A large amount of driftwood was brought down by the current. Five trees lodged in or near the channels, where they were considered obstructions to navigation, and were removed by the United States snag boat. A mass of driftwood which collected at the Reservoir Outlet was also removed.

About 300 linear feet of the training dike, which had settled, were raised with stone left over from the reconstruction of the sea wall along the lower portion of the Washington Channel.

Six of the twelve outlet gates which were found to have been somewhat injured from the effects of the steamboat swells, since they were last repaired in 1899, were taken out and placed in good condition.

A portion of the park area was cleared of brush, about 400 linear feet of the old fence near Easbys Point was taken down and partly rebuilt, and other similar work incidental to the improvement was done.

* * * * * * *

In response to the urgent popular demand for this additional park space it is regarded as especially desirable that the dredging of the adjacent river channels and the filling of Potomac Park be completed at the earliest practicable date, and it is hoped that the full amount estimated for the ensuing year may be appropriated.

Without waiting for the completion of the river improvement certain of the roads and parts of the park surface could be advantageously and economically prepared for park purposes, in conjunction with the work of the river improvement, as has been pointed out in preceding reports of this office, and certain small portions of the park could thus be rendered accessible to the public.

A small tract of land, containing about 31 acres, adjacent to the Monument grounds and separated from the remainder of the park, was transferred to the charge of the officer in charge of public buildings and grounds during the past year.

All unauthorized occupation of the portion of Potomac Park under the control of this office has ceased.

DUMPING IN POTOMAC PARK.

Deposits by citizens, at their own expense, in Potomac Park of desirable clean earth, free from objectionable matter, have always been permitted by this office, subject to certain restrictions which guard the interests of the United States. These permits are in regular form and are of record.

During the past year this privilege has been a great convenience to various private parties, and at the same time the United States has obtained, in this way and without cost to itself, about 35,000 cubic yards of good material, deposited and graded free of cost at localities remote from the river, where deposit from dredging is most expensive, or thrown up in embankments which will later serve for retaining and grading deposited material, thus reducing the cost of future dredging and deposit. The total amount of good material placed in this manner upon Potomac Park for a number of years past is estimated as 300,000 cubic yards.

MAINTENANCE.

The improvement has reached a stage where the maintenance and preservation of the reservation require attention. The growth of weeds and underbrush which, in the summer season especially, renders access to the various parts of the work difficult, should be cleared up each year until the reservation is ready to be laid out and graded. Annual repairs will also be needed on the wall and the reservoir gates.

The proper police supervision of this extensive area of 621 acres has also become a matter of importance. In order to prevent infraction of the law, trespasses, etc., the reservation should be patrolled.

It is estimated that $5,000 will be required per annum for maintenance.

It is also estimated that the sum of $400,000 can be profitably expended during the fiscal year ending June 30, 1904, in carrying on work under the approved project. The items making up the foregoing amount are as follows:

Dredging in tidal reservoir, 520,000 cubic yards, at 15 cents	$78,000
Dredging in Virginia channel, 640,000 cubic yards, at 15 cents	96,000
Dredging in Washington channel, 50,000 cubic yards, at 15 cents	7,500
Dredging at junction of Washington and Virginia channels, 50,000 cubic yards, at 15 cents	7,500
(The dredged material to be deposited on Potomac Park.)	

Construction of reservoir inlet gates	$140,000
Extension of training dike and raising existing dike where required	30,000
Repair of sea wall	5,000
Maintenance	5,000
Contingencies, about 8 per cent	31,000
Total	400,000

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Money statement.

July 1, 1901, balance unexpended		$92,988.17
Amount appropriated by river and harbor act approved June 13, 1902		75,000.00
		167,988.17
June 30, 1902, amount expended during fiscal year		80,399.93
July 1, 1902, balance unexpended		87,588.24
July 1, 1902, outstanding liabilities		648.00
July 1, 1902, balance available		86,940.24
Amount (estimated) required for completion of existing project		519,020.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$395,000.00	
For maintenance of improvement	5,000.00	
		400,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

APPROPRIATIONS FOR THE IMPROVEMENT.

August 2, 1882	$400,000
July 5, 1884	500,000
August 5, 1886	375,000
August 11, 1888	300,000
September 19, 1890	260,000
July 13, 1892	200,000
August 18, 1894	150,000
June 3, 1896	100,000
March 3, 1899 (appropriated, $100,000; allotted Potomac River below Washington, $26,000)	$74,000
June 13, 1902	75,000
Total	2,434,000

CONTRACT IN FORCE.

Contractor: Atlantic, Gulf and Pacific Company of New York, N. Y., for dredging.

Amount: 460,000 cubic yards, more or less, in the Virginia Channel above Long Bridge; 80,000 cubic yards, more or less, in the Virginia Channel below Long Bridge, and 125,000 cubic yards, more or less, in the Washington channel.

Date of contract: August 15, 1900.

Approved: September 5, 1900.

Date for commencement: On or before September 27, 1900; extended to January 27, 1901.

Date for completion: Not less than 50,000 cubic yards of material to be dredged and deposited from the Virginia Channel and 30,000 cubic yards from the Washington channel each month, excepting that these amounts of dredging per month will not be required during months of December, January, and February.

Rate: 12.8 cents per cubic yard for dredging in the Virginia Channel and 14.8 cents per cubic yard for dredging in the Washington Channel.

COMMERCIAL STATISTICS.

[Furnished by Mr. J. W. Averill, Washington, D. C.]

Receipts and shipments.

Calendar year—	Coal.	Ice.	Lumber.	Sand.	Wood.	Miscellaneous.	Total.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
1901	252,259	93.537	68,844	67,962	32,550	121,332	636,484

In addition to the foregoing, the estimated amount of miscellaneous freight received and shipped by the Norfolk, Baltimore, and river steamers during the year, as obtained from the agents of the different lines, is 70,067 tons.

The amount of sand and stone reported includes that brought from and shipped to points below Alexandria only, and not what was handled around the city.

Number of vessels of various classes arriving and departing.

Calendar year—	Steamers drawing from 5 to 15 feet, 100 to 600 tons.	Vessels drawing from 10 to 21 feet 300 to 2,600 tons.	Vessels drawing from 4 to 10 feet, 30 to 400 tons.	Barges drawing from 5 to 12 feet, 100 to 700 tons.
1901	1,350	355	2,069	585

Ferry and local passenger steamers are not included in the above.

K 2.

IMPROVEMENT OF POTOMAC RIVER BELOW WASHINGTON, DISTRICT OF COLUMBIA

WORK OF THE FISCAL YEAR ENDED JUNE 30, 1902.

Dredging at Mattawoman shoal, under contract with Rittenhouse Moore, of Mobile, Ala., which was in progress at the close of the last fiscal year, was continued with the dredge *Alabama* until July 11, when the dredging at this bar was completed, except the excavation of the hard material encountered, for the removal of which a supplemental contract was later entered into.

The plant was at once transferred to Smiths Point upper shoal, where work was in progress continually until August 24, when the dredging was completed and the dredge *Alabama* removed from the shoal.

On August 1 the dredging of Smiths Point lower shoal was begun by the dredge *Pugh* and continued until September 26, when the dredging required at this shoal was practically completed, except the removal of some lumps and ridges temporarily left behind by the dredge, and the plant was transferred to Maryland Point shoal by the contractor. Dredging operations were in progress at Maryland Point shoal up to November 29, 1901, when the contractor withdrew his plant from the work for the winter.

On April 28, 1902, dredging was resumed at Maryland Point shoal, where the dredging was completed on May 16 and the plant at once taken to Smiths Point lower shoal, where the small amount of work remaining to be done to bring the channel to the full specified dimensions was completed May 27.

A supplemental contract with Mr. Moore for the removal of the hard material at Mattawoman shoal and for a small-additional amount of dredging at some of the lower shoals was made April 30 and approved May 5, 1902. On June 9 the dredging of the hard material at Mattawoman shoal was begun under the supplemental contract and prosecuted continuously until June 30, when injuries to the bucket and other machinery made it necessary to temporarily withdraw the dredge for repairs. At that time two cuts, affording a total width of 80 feet, had been dredged entirely through the upper hard ridge, and a third cut 40 feet wide had been dredged a little more than halfway through the ridge.

The total amount of material removed from the different shoals in the Lower Potomac River during the past fiscal year, under both contracts, was 397,880.5 cubic yards, making a total of 1,072,267.5 cubic yards of material dredged to June 30, 1902. Of this amount 697,531.2 cubic yards have been removed from Mattawoman shoal, 92,878 from Smiths Point upper shoal, 120,312.1 from Smiths Point lower shoal, and 161,546.2 from Maryland Point shoal.

During the progress of dredging operations on the Lower Potomac the wreck of a schooner (name unknown) about 80 feet long and 30 feet beam was encountered in the cut at Maryland Point shoal. This wreck was partly removed by the contractor during November, 1901, and its removal was completed by him during May following.

An examination of the beds of hard material crossing the channel at Mattawoman shoal was made during September, 1901, and supplemented by a further examination in November, 1901, by hired labor and the use of the United States boring plant. The material was found to consist mainly of hard and compact gravel and sand, overlaid by a thin layer of mud. The subsequent dredging operations have shown these observations to be correct and have revealed the presence of a few loose stones, the largest about 48 cubic feet in size.

The available balance will be applied to the dredging required for the completion of the original project early in the ensuing fiscal year.

For commercial statistics see report on improving Potomac River at Washington, D. C., to which should be added a tonnage of about 300,000, due to trade at Alexandria, Quantico, and other points below Washington.

No further appropriation is asked.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$126, 687. 55
June 30, 1902, amount expended during fiscal year	35, 893. 82
July 1, 1902, balance unexpended	90, 793. 73
July 1, 1902, outstanding liabilities	278. 00
July 1, 1902, balance available	90, 515. 73
July 1, 1902, amount covered by uncompleted contracts	39, 945. 00

APPROPRIATIONS.

March 3, 1899 (by allotment from appropriation of $100,000 for improving Potomac River, etc.)	$26,000
June 6, 1900	52,000
March 3, 1901	98,000
Total	176,000

CONTRACT IN FORCE.

Contractor: Rittenhouse Moore, of Mobile, Ala., for dredging
Amount: 960,000 cubic yards, more or less.
Date of contract: November 1, 1899.
Approved: November 14, 1899.
Date for commencement: December 14, 1899.
Date for completion: Dredging operations to be continued so long as funds are available and appropriations may be made for the work, not less than 50,000 cubic yards to be dredged in each month.
Rate: 7.2 cents per cubic yard at Mattawoman shoal, Smiths Point shoals, Maryland Point shoal, and 7 cents per cubic yard at Kettle Bottom shoal.
Supplemental contract: Excavation of hard material at Mattawoman shoals.
Amount: 60,000 cubic yards, more or less.
Date of contract: April 30, 1902.
Approved: May 5, 1902.
Rate: 52 cents per cubic yard.

K 3

IMPROVEMENT OF ANACOSTIA RIVER, DISTRICT OF COLUMBIA.

Congress in act (Public—No. 154) making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes, provided the following:

> Improving Anacostia River, District of Columbia, with a view to the interests of commerce and navigation, in accordance with such portions of the report submitted in House Document Numbered Eighty-seven, Fifty-fifth Congress, third session, as relates to section one of said river, being the portion below the Navy-Yard Bridge, one hundred and fifty thousand dollars.

The report referred to was made under date of December 14, 1898, and in pursuance of the following joint resolution of Congress approved April 11, 1898:

> That the Secretary of War be, and he is hereby, directed to prepare and submit to Congress forthwith a project for the improvement of the Anacostia River and the reclamation of its flats from the line of the District of Columbia to the mouth of said river, with an estimate of the cost of the same and a report on the area and ownership of the land to be reclaimed, and, if any portion of said land is vested in private persons, an estimate of the cost of acquiring the same.

In that resolution, as may be seen, improvement of the river and reclamation of the flats (the former undoubtedly in the interest of navigation and commerce, and the latter—reclamation—in the interest, largely, if not entirely, of sanitation) were the objects named.

The report of December 14, 1898, to which attention is respectfully invited, proposes for section 1—from the mouth of the river to the Navy-Yard Bridge—the dredging a channel from the river mouth to the navy-yard, to afford a depth of 20 feet for a width of 400 feet.

Outside of the bounding lines of the widths named the dredged depths to be gradually reduced up to, or near to, the bulkheads of the harbor lines. This space, thus dredged, outside of the bounding lines of the main channel, could be used by small craft or for anchorage grounds for vessels of suitable draft.

Some additional width for turning in front of the navy-yard would undoubtedly be desirable.

The dredged material would have to be in any case largely deposited upon the flats and retained in place by sea walls of suitable material.

Some of the items of the estimate of 1898 (December 1) relate to embankment protection of the flats reclaimed as proposed in the report of that date, and to drainage, and, in fact, to elevation of the flats as a sanitary measure.

The items in view in this present report are those mainly pertaining to commerce and navigation interests, as appear to be considered by the act of June 13, 1902.

It is proposed to apply the appropriation of June 13 to the project as referred to in that act.

The sum of $320,000 can be profitably expended during the fiscal year ending June 30, 1904, in furtherance of the project adopted.

For estimate of commerce to be benefited, reference is respectfully made to the statistics accompanying the annual report of operations for improvement of the Potomac River at Washington, D. C.

Money statement.

July 1, 1902, unexpended balance (improving Potomac River, "Eastern Branch," act of Sept. 19, 1890)	$1,463.06
Appropriated, act June 13, 1902	150,000.00
July 1, 1902, balance unexpended	151,463.06
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	320,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

September 19, 1890 (allotment from appropriation for improving Potomac River)	20,000
June 13, 1902	150,000
Total	170,000

K 4.

IMPROVEMENT OF BRETON BAY AND PATUXENT RIVER, MARYLAND

Improvement of these streams was included in a lump sum of $9,000 appropriated by act of Congress of June 13, 1902, the specific amounts to be allotted by the War Department. As recommendations for these allotments have to await the results of examinations shortly to be undertaken, no more definite report can be here made.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902	$9,000.00
July 1, 1902, balance unexpended	9,000.00

K 5.

IMPROVEMENT OF YORK RIVER, VIRGINIA.

WORK OF THE FISCAL YEAR ENDED JUNE 30, 1902.

Dredging in the channel, under contract with John Miller, of Washington, D. C., was in progress at the close of the last fiscal year and was continued until August 14, 1902, when the work proposed under this contract was completed. The total amount of material dredged from the channel during the fiscal year was 9,262.3 cubic yards, making a total of 31,987.3 cubic yards dredged under this contract. The material was deposited mainly behind the training dike, adding greatly to its stability. Some minor repairs were made to the dike by hired labor.

An appropriation for this stream and others in gross, subject to allotment by the Secretary of War, was made in the act approved June 13, 1902. It is proposed to apply such allotment as may be made from this appropriation to maintenance and repairs.

The sum of $10,000 can be profitably expended during the fiscal year ending June 30, 1904, in maintenance of the dike and in dredging the channel.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended		$3,134.79
June 30, 1902, amount expended during fiscal year		2,513.81
July 1, 1902, balance unexpended		620.98
July 1, 1902, amount covered by uncompleted contracts		518.00
Amount (estimated) required for completion of existing project		69,050.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$8,000.00	
For maintenance of improvement	2,000.00	
		10,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

The following appropriations have been made:

June 14, 1880	$10,000	July 13, 1892	$35,000
March 3, 1881	25,000	August 18, 1894	20,000
August 2, 1882	25,000	June 3, 1896	16,000
July 5, 1884	20,000	March 3, 1899	10,000
August 5, 1886	18,750		
August 11, 1888	30,000	Total	239,750
September 19, 1890	30,000		

These appropriations have been applied to work under the original project of 1880, the amended project of 1884, and the further amended project of 1887.

CONTRACT IN FORCE.

Contractor: John Miller, of Washington, D. C., for dredging.
Amount: 40,000 cubic yards, more or less.
Date of contract: October 29, 1900.
Approved: November 14, 1900.
Date for commencement: December 15, 1900.
Date for completion (including dredging in Mattaponi and Pamunkey rivers, Milford Haven and Urbana Creek, Virginia, under the same contract): Within fifteen months from date of commencement; not less than 7,000 cubic yards to be dredged per month. The contractor was allowed a reasonable additional time for completion of the work.
Rate: 16 cents per cubic yard.

COMMERCIAL STATISTICS.

* * * * * * *

Repeated efforts were made to obtain commercial statistics for years subsequent to 1894, but they could not be obtained.

It is stated that the principal line of steamers navigating this river carried 59,273 tons of freight during the year 1900, and 55,951 tons during the year 1901.

K 6.

IMPROVEMENT OF OCCOQUAN CREEK, VIRGINIA.

WORK OF THE FISCAL YEAR ENDED JUNE 30, 1902.

The available funds having been practically exhausted no work of improvement could be undertaken during the past fiscal year.

It having been reported that considerable quantities of fine stone screenings and refuse had been dumped or washed into Occoquan Creek from a quarry, an investigation was made and steps were taken to prevent such action in future.

An appropriation for this stream and others in gross, subject to allotment by the Secretary of War, was made in the act approved June 13, 1902. It is proposed to apply the available balance and any allotment that may be made from the above appropriation to dredging and dike construction.

The sum of $5,000 can be profitably expended during the fiscal year ending June 30, 1904, in dredging and dike construction.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$384.58
June 30, 1902, amount expended during fiscal year	112.55
July 1, 1902, balance unexpended	272.03
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	$5,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

September 19, 1890	$10,000
July 13, 1892	5,000
August 18, 1894	5,000
June 3, 1896	2,500
March 3, 1899	2,500
Total	25,000

COMMERCIAL STATISTICS.

[Furnished by Messrs. L. Ledman, Tyson Janney, and Selecman, Lynn & Co., Occoquan, Va.]

Receipts and shipments by water, 1901.

	Tons.		Tons.
Coal	50	Wood	2,000
Fertilizers	150	Miscellaneous	700
Flour and grain	800	Rock	11,520
Lumber	2,000		
Railroad ties	2,000	Total	20,220
Sand	1,000		

Arrival and departure of vessels, 1901.

Steam, drawing less than 10 feet	192
Sail, drawing less than 10 feet	160
Barges, flatboats, etc	50

It is reported that the work done has lessened the cost of shipping, since vessels can now load more heavily at the wharves, whereas formerly part of the cargo had to be taken out to them in lighter draft boats.

K 7.

IMPROVEMENT OF LOWER MACHODOC CREEK, VIRGINIA.

WORK OF THE FISCAL YEAR ENDED JUNE 30, 1902.

The available funds having been practically exhausted no work of improvement could be undertaken during the past fiscal year.

An appropriation for this stream and others in gross, subject to allotment by the Secretary of War, was made in the act approved June 13, 1902.

The annual report for the fiscal year ended June 30, 1902, stated the amount necessary for completion to be $2,100, and which amount could be profitably expended during the fiscal year ending June 30, 1903. Whatever allotment may be made from the foregoing act of June 13, 1902, for the work, will reduce, by so much, the above-stated amount for completion.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$222.13
June 30, 1902, amount expended during fiscal year	46.25
July 1, 1902, balance unexpended	175.88

APPROPRIATIONS.

The following appropriations have been made:

July 13, 1892	$3,000
August 18, 1894	3,000
June 3, 1896	1,500
March 3, 1899	1,500
Total	9,000

* * * * * * *

K 8.

IMPROVEMENT OF NOMINI CREEK, VIRGINIA.

WORK DONE DURING THE FISCAL YEAR ENDED JUNE 30, 1902.

The available funds being insufficient for the economical prosecution of operations in accordance with the general project, no work of improvement was in progress during the past fiscal year. It was proposed to apply the funds available to repair of the jetty, but the engineer plant being urgently needed on the Potomac River these repairs have been deferred until the working season of 1902.

No appropriation for this improvement was made in the river and harbor act of June 13, 1902.

The sum of $12,000 can be profitably expended during the fiscal year ending June 30, 1904, in dredging and jetty construction. An appropriation of less than $6,000 can not be economically expended at this locality.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$3,166.38
June 30, 1902, amount expended during fiscal year	150.00
July 1, 1902, balance unexpended	3,016.38
Amount (estimated) required for completion of existing project	35,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	12,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

The following appropriations have been made:

May 3, 1873	$10,000	September 19, 1890	$5,000
June 23, 1874	6,000	July 13, 1892	10,000
March 3, 1875	5,000	August 18, 1894	5,000
March 5, 1879	2,500	June 3, 1896	2,500
June 14, 1880	5,000	March 3, 1899	10,000
March 3, 1881	2,000		
August 2, 1882	2,000	Total	70,000
August 11, 1888	5,000		

COMMERCIAL STATISTICS.

Receipts and shipments by water, 1901.

[Furnished by Mr. J. L. Healy, Templeman, Va.]

	Tons.		Tons.
Farm produce	5,000	General merchandise	3,000
Grain	500	Wood	10,000
Lumber	200	Canned goods	500
Oysters	200	Fertilizer	500
Railroad ties	2,500		

* * * * * * *

Arrival and departure of vessels, 1901.

Steam, drawing less than 10 feet	312
Sail, drawing less than 10 feet	100
Barges, flatboats, etc	4

It is reported that the improvement made thus far has been of great benefit to navigation.

K 9.

IMPROVEMENT OF RAPPAHANNOCK RIVER, VIRGINIA.

WORK OF THE FISCAL YEAR ENDED JUNE 30, 1902.

Dredging at Fredericksburg bar under contract with W. H. French, of Norfolk, Va., was begun July 23 and completed October 26, 1901. As a result of these operations a channel 60 feet wide and 10 feet deep was dredged through the upper part of Fredericksburg bar, with a turning basin of the same depth and 200 feet wide in front of the steamboat wharf. Ten thousand one hundred and sixty-eight and five-tenths cubic yards of material were dredged under this contract, and in addition to the dredging a large bowlder was removed from the channel by the contractor. The dredge used by the contractor was small.

Several lines of wattling were constructed for the protection of the fill, a trough was built for controlling the discharge of a spring over the fill, and minor repairs were made to the dike and plant. This work was done by hired labor. It was expected that the repair of the remaining portions of the dikes could be undertaken with the small balance available, but satisfactory prices for the necessary material and labor could not be obtained.

At Fredericksburg bar new deposits of sand are formed by each recurring freshet, this bar being near the head of tide water. The annual reports for a number of years past have referred to the necessity of an annual appropriation of $7,500 for the removal of these particular deposits. The old timber dikes for the regulation of the channel, built to elevations of about 6 feet above low tide, have suffered greatly from decay, combined with the effects of ice and freshets, and portions of these dikes have been practically destroyed, permitting some of the material deposited behind them to wash back into the channel. The condition of the dikes is rapidly becoming more and more serious. Owing to the meager appropriations which have recently been made for this river, the funds have been mainly required for the maintenance of the channel at Fredericksburg bar, as above referred to; but little could be done toward the maintenance of the dikes or the protection of the newly made fills, and no considerable headway could be made toward the completion of the general project.

The full sum of $40,000 requested for this improvement is badly needed and can be profitably expended during the fiscal year ending June 30, 1904, in dredging and dike construction and maintenance, in accordance with the approved project.

During the ensuing year the available balance and appropriation made by act of June 13, 1902, will be applied to dredging and dike construction and repair.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended		$5,684.29
Amount appropriated by river and harbor act approved June 13, 1902		25,000.00
		30,684.29
June 30, 1902, amount expended during fiscal year		4,149.20
July 1, 1902, balance unexpended		26,535.09
July 1, 1902, outstanding liabilities		12.00
July 1, 1902, balance available		26,523.09
Amount (estimated) required for completion of existing project		89,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$30,000.00	
For maintenance of improvement	10,000.00	
		40,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

The following appropriations have been made:

March 3, 1871	$15,000	August 5, 1886	$20,000
June 10, 1872	15,000	August 11, 1888 ($15,000, of which $3,000 was for Urbana)	12,000
March 3, 1873	15,000	September 19, 1890	15,000
June 23, 1874	7,000	July 13, 1892	20,000
March 3, 1875	5,000	August 18, 1894	10,000
August 14, 1876	10,000	June 3, 1896	8,000
August 18, 1878	13,500	March 3, 1899	15,000
March 3, 1879	10,000	June 13, 1902	25,000
June 14, 1880	25,000		
March 3, 1881	15,000	Total	292,500
August 2, 1882	17,000		
July 5, 1884	20,000		

CONTRACT IN FORCE.

Contractor: W. H. French, of Norfolk, Va., for dredging.

Amount: 10,500 cubic yards, more or less.

Date of contract: June 4, 1901.

Approved June 17, 1901.

Date for commencement: On or before July 19, 1901.

Date for completion: On or before September 19, 1901. The contractor was allowed a reasonable additional time for completion of the work.

Rate: 32 cents per cubic yard.

COMMERCIAL STATISTICS.

Arrival and departure of vessels, 1901.

Steam	
Drawing 10 feet or more	760
Drawing less than 10 feet	280
Sail:	
Drawing 10 feet or more	1,340
Drawing less than 10 feet	380
Barges, flatboats, etc	580

It is reported that the work done on this improvement has greatly reduced freight rates, both by rail and water.

K 10.

IMPROVEMENT OF URBANA CREEK, VIRGINIA.

WORK OF THE FISCAL YEAR ENDED JUNE 30, 1902.

A contract was made October 29, 1900, for a small amount of dredging to be done in Urbana Creek, the work to be done under the same contract as that for dredging to be done in York, Mattaponi, and Pamunkey rivers, and Milford Haven, Virginia.

The contractor has been engaged at other of the above-named localities, and no work was done at Urbana Creek during the past fiscal year. It will be undertaken early in the ensuing year.

The sum of $10,000 can be profitably expended during the fiscal year ending June 30, 1904, in dredging, chiefly at the inner bar, and in construction of jetty for the maintenance of the outer channel.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$778.00
July 1, 1902, balance unexpended	778.00
July 1, 1902, amount covered by uncompleted contracts	720.00
Amount (estimated) required for completion of existing project	36,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	10,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

The following appropriations have been made:

March 3, 1879	$5,000	September 19, 1890	$3,000
June 14, 1880	2,500	July 13, 1892	3,000
March 3, 1881	4,000	August 18, 1894	3,000
August 2, 1882	4,000	June 3, 1896	3,000
August 11, 1888 (included in an appropriation of $15,000 for Rappahannock River)	3,000	March 3, 1899	3,000
		Total	33,500

CONTRACT IN FORCE.

Contractor: John Miller, of Washington, D. C., for dredging.
Amount: 3,000 cubic yards, more or less.
Date of contract: October 29, 1900.
Approved: November 14, 1900.
Date for commencement: December 15, 1900.
Date for completion (including dredging in York, Mattaponi, and Pamunkey rivers, and Milford Haven, Virginia, under the same contract): Within fifteen months from date of commencement, not less than 7,000 cubic yards to be dredged per month. The contractor was allowed a reasonable additional time for completion of the work.
Rate: 24 cents per cubic yard.

COMMERCIAL STATISTICS.

Arrivals and departures of vessels, 1901.

Class.	Reported by Mr. F. A. Bristow.	Reported by Mr. J. D. Gressitt.
Steam:		
Drawing 10 feet or more	900	840
Drawing less than 10 feet	1,100	1,400
Sail:		
Drawing 10 feet or more	400	400
Drawing less than 10 feet	3,000	3,200
Barges, flatboats, etc	150	200
Total	5,550	6,040

These statistics are not regarded as entirely correct.

* * * It is reported that a better steamer service has been promised when the channel improvement has progressed further.

A daily mail steamer line, running from Carters Creek, or Irvington, to Urbana, was established during 1896. The work done on this improvement has greatly reduced freight rates and permitted the use of larger vessels.

K 11.

IMPROVEMENT OF HARBOR AT MILFORD HAVEN, VIRGINIA.

WORK DONE DURING THE FISCAL YEAR ENDED JUNE 30, 1902.

A contract was made October 29, 1900, for dredging a narrow channel through the inner bar at Milford Haven, the work to be done under the same contract as that for dredging to be done in York, Mattaponi, and Pamunkey rivers, and Urbana Creek, Virginia.

The contractor has been engaged at other of the above-mentioned localities and no work was done at Milford Haven during the past fiscal year. It will be undertaken early in the ensuing year.

During the year an action at law was instituted in the supreme court of the District of Columbia against a former contractor and his surety, and judgment in the sum of $3,032.97 recovered thereon, which amount was deposited in the Treasury to the credit of the appropriation.

The sum of $5,000 was appropriated for the work by act of Congress of June 13, 1902. No further appropriation is regarded as necessary.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$3,609.00
Amount of judgment recovered	3,032.97
Amount appropriated by river and harbor act approved June 13, 1902	5,000.00
July 1, 1902, balance unexpended	11,641.97
July 1, 1902, amount covered by uncompleted contracts	1,920.00

APPROPRIATIONS.

The following appropriations have been made:

March 3, 1899	$12,500.00
June 13, 1902	5,000.00
Total	17,500.00
Amount of judgment recovered	3,032.97
Total	20,532.97

CONTRACT IN FORCE.

Contractor: John Miller, of Washington, D. C., for dredging.
Amount: 12,000 cubic yards, more or less.
Date of contract: October 29, 1900.
Approved: November 14, 1900.
Date for commencement: December 15, 1900.

Date for completion (including dredging in York, Mattaponi, and Pamunkey rivers and Urbana Creek, Virginia, under the same contract): Within fifteen months from date of commencement, not less than 7,000 cubic yards to be dredged per month. The contractor was allowed a reasonable additional time for completion of the work.

Rate: 16 cents per cubic yard.

COMMERCIAL STATISTICS, 1901.

[Furnished by Baltimore, Chesapeake and Atlantic Railway Company.]

	Tons.		Tons.
Coal	12	Ice	9
Crabs	97	Iron	27
Farm produce	216	Live stock	65
Fish	125	Lumber	9
Fertilizer	33	Mill products	99
Flour	200	Oysters	15,146
General merchandise	774	Wood	3
Grain	41		

Vessels arriving and departing, 1901.

Class.	Number.	Tonnage.
Steam, drawing less than 10 feet	4	2,400
Sail:		
Drawing 10 feet or more	8	900
Drawing less than 10 feet	70	4,400

K 12.

IMPROVEMENT OF MATTAPONI RIVER, VIRGINIA.

WORK DONE DURING THE FISCAL YEAR ENDED JUNE 30, 1902.

Work under contract with John Miller, of Washington, D. C., was begun at Line Tree bar on January 29. By April 23, 3,930.8 cubic yards of material had been removed and deposited behind retaining embankments, completing the channel 40 feet wide and 5½ feet deep entirely through this bar.

Dredging in the channel at Latane bar was begun May 3 and continued until June 3, 1902, when the limit of the work to be done under the contract was reached, 6,354.4 cubic yards of material having been dredged from this channel and deposited behind embankments, resulting in a channel 40 feet wide, 5½ feet deep, and 1,200 feet long, or nearly one-third of the length of the bar.

The total amount of material dredged from the Mattaponi River under this contract was 10,285.2 cubic yards.

The contractor's plant was unsatisfactory, which, together with delays occasioned by ice, freshets, and low tides, rendered the rate of progress less than was anticipated.

In addition to the dredging, a large tree which had slid into the river near Aylett, obstructing navigation, was removed by the contractor.

Upon the completion of the dredging the recently formed embankments were well planted with tree cuttings to protect them from erosion.

The sum of $4,000 can be profitably expended during the fiscal year ending June 30, 1904, in dredging and removal of snags, logs, and overhanging trees. An appropriation of less than $3,000 can not be economically expended at this locality, except in snagging.

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Money statement.

July 1, 1901, balance unexpended	$4,111.24
June 30, 1902, amount expended during fiscal year	3,473.95
July 1, 1902, balance unexpended	637.29
July 1, 1902, outstanding liabilities	12.00
July 1, 1902, balance available	625.29
July 1, 1902, amount covered by uncompleted contracts	236.56
Amount (estimated) required for completion of existing project	42,300.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	4,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

The following appropriations have been made:

June 4, 1880	$2,500	July 13, 1892	$4,000
March 3, 1881	3,300	August 18, 1894	4,000
July 5, 1884	2,500	June 3, 1896	2,500
August 5, 1886	5,000		
August 11, 1888	3,000	Total	29,800
September 19, 1890	3,000		

CONTRACT IN FORCE.

Contractor: John Miller, of Washington, D. C., for dredging.
Amount: 11,600 cubic yards, more or less.
Date of contract: October 29, 1900.
Approved: November 14, 1900.
Date for commencement: December 15, 1900.
Date for completion (including dredging in York and Pamunkey rivers, Milford Haven, and Urbana Creek, Virginia, under the same contract): Within fifteen months from date of commencement, not less than 7,000 cubic yards to be dredged per month. The contractor was allowed a reasonable additional time for completion of the work.
Rate: 23 cents per cubic yard.

COMMERCIAL STATISTICS.

Receipts and shipments, 1901.

[Furnished by Mr. J. C. Fox, Aylett, Va.]

	Tons.		Tons.
Coal	50	Merchandise	4,604
Farm products	1,100	Ties	1,000
Grain	300		
Lumber	5,000	Total	12,054

Vessels arriving and departing during 1901.

Class.	Number.	Tonnage.
Steam, drawing less than 10 feet	100	7,000
Sail, drawing less than 10 feet	50	3,500
Barges, flatboats, etc	1,000	150,000

Repeated efforts were made to obtain commercial statistics for the years 1895–1898, but they could not be procured. It is stated that the commerce of the river in 1899 was approximately 44,700 tons.

K 13.

IMPROVEMENT OF PAMUNKEY RIVER, VIRGINIA.

WORK DONE DURING THE FISCAL YEAR ENDED JUNE 30, 1902.

Dredging at Buckland bar, under contract with John Miller, of Washington, D. C., was begun August 29, 1901, and was completed December 13, 1901. As a result of these operations a channel 100 feet wide and 7 feet deep was dredged entirely through this bar, 7,546.3 cubic yards of material being excavated and deposited behind an embankment built to the left of the channel. The dredge employed by the contractor was small, and the work did not progress with the rapidity which was anticipated.

The sum of $3,500 can be profitably expended during the fiscal year ending June 30, 1904, in dredging and removal of snags, logs, and wrecks. An appropriation of less than $3,000 can not be economically expended at this locality except in snagging.

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Money statement.

July 1, 1901, balance unexpended	$2,875.17
June 30, 1902, amount expended during fiscal year	2,304.67
July 1, 1902, balance unexpended	570.50
July 1, 1902, amount covered by uncompleted contracts	173.57
Amount (estimated) required for completion of existing project	7,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	3,500.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897.

APPROPRIATIONS.

The following appropriations have been made:

June 14, 1880	$2,500
March 3, 1881	2,500
August 2, 1882	2,500
August 5, 1886	5,000
August 11, 1888	3,000
September 19, 1890	3,000
July 13, 1892	$3,000
August 18, 1894	2,000
June 3, 1896	2,000
Total	25,500

CONTRACT IN FORCE.

Contractor: John Miller, of Washington, D. C. for dredging.

Amount: 9,200 cubic yards, more or less.

Date of contract: October 29, 1900.

Approved: November 14, 1900.

Date for commencement: December 15, 1900.

Date for completion (including dredging in York and Mattaponi rivers, Milford Haven, and Urbana Creek, Virginia, under the same contract): Within fifteen months from date of commencement, not less than 7,000 cubic yards to be dredged per month. The contractor was allowed a reasonable additional time for completion of the work.

Rate: 23 cents per cubic yard.

COMMERCIAL STATISTICS.

* * * * * * *

It is stated that the commerce of the river in 1899 amounted to approximately 44,600 tons, consisting principally of wood, lumber, grain, ties, coal, and general merchandise, carried in sailing vessels.

K 14.

IMPROVEMENT OF JAMES RIVER, VIRGINIA.

No work of channel improvement was carried on during the fiscal year, the available balance of funds being too small to warrant undertaking anything beyond necessary examinations and surveys to show the condition and needs of the channels, and from which to make estimates of cost of future work. The existing works for improvement and the floating and other plant were taken care of and the usual necessary routine work of the office was carried on.

* * * * * * *

A portion of the left bank of the bluff bordering Dutch Gap Canal slid into the canal on the 13th of May last, reducing by about 10 per cent the area of cross section of the channel, though not materially impairing the section for navigation. Slides from the same bluff but on a smaller scale have occurred before now. The face of the bluff should be graded and protection work should be placed along its front. This matter will be treated of in the project to be rendered for application of the funds for improving James River appropriated by act of Congress of June 13, 1902. The item containing this appropriation is as follows:

> Improving James River, Virginia: Continuing improvement, and for extending the improvement of James River to the head of navigation at the docks, in accordance with the report submitted in House Document numbered two hundred and thirty-four, Fifty-sixth Congress, first session, three hundred thousand dollars: *Provided*, That no part of said amount shall be expended for turning basins or areas mentioned in said report: *And provided further*, That not more than one-half of said appropriation shall be expended for the improvements above the city line of the city of Richmond.

An estimate for improvement of James River at Richmond is contained in a report of a survey made in 1899, in accordance with the requirements of act of Congress approved March 3, 1899. The report was printed in Document No. 234, House of Representatives, Fifty-sixth Congress, first session.

The sum of $400,000 can be profitably expended during the fiscal year ending June 30, 1904, in furtherance of the general project.

With this is an extract from a report of Mr. S. H. Yonge, assistant engineer, containing valuable information in detail relating to the improvement.

Money statement.

July 1, 1901, balance unexpended	$51,029.75
Amount appropriated by river and harbor act approved June 13, 1902	300,000.00
	351,029.75
June 30, 1902, amount expended during fiscal year	20,978.79
July 1, 1902, balance unexpended	330,050.96
July 1, 1902, outstanding liabilities	931.00
July 1, 1902, balance available	329,119.96

APPROPRIATIONS.

The following appropriations have been made for this work:

July 11, 1870	$50,000	July 5, 1884	$75,000
March 3, 1871	50,000	August 5, 1886	112,500
June 8, 1872	50,000	August 11, 1888	225,000
March 3, 1873	75,000	September 19, 1890	200,000
June 23, 1874	50,000	July 13, 1892	200,000
March 3, 1875	50,000	August 18, 1894	100,000
August 14, 1876	60,000	June 3, 1896	120,000
June 18, 1878	70,000	March 3, 1899	150,000
March 3, 1879	75,000	June 13, 1902	300,000
June 14, 1880	75,000		
March 3, 1881	60,000	Total	2,222,500
August 2, 1882	75,000		

CONTRACT IN FORCE.

Contractor: P. Sanford Ross, Incorporated, of Jersey City, N. J., for dredging, removing rock, repairing jetties, and constructing dike.

Estimated amount of contract: $84,460.

Date of contract: October 2, 1899.

Approved: October 14, 1899.

Date of commencement: On or before November 3, 1899.

Date for completion: February 22. 1901, extended to May 7, 1901, to June 6, 1901, and to July 6, 1901.

COMMERCIAL STATISTICS.

Receipts and shipments by water during the calendar year 1901.

Articles.	Port of Richmond, Va.			Points on James River other than Richmond, Va.			Total tonnage.
	Receipts.	Shipments.	Amount.	Receipts.	Shipments.	Amount.	
Brick	213	196	409	889	[a]17,426	18,315	18,724
Coal	53,257	238	53,495	[a]5,116	200	5,316	58,811
Cement, lime, etc	7,351	3	7,354	741	3	744	8,098
Cattle				34	179	213	213
Cotton					35	35	35
Cord wood	520	6,502	7,022	750	[a]35,125	35,875	42,897
Fertilizer and fertilizer material	13,534	2,716	16,250	[a]1,464	20	1,484	17,734
Flour				231	30	261	261
Fish and oysters	780		780	94	122	216	996
Fruit				8	53	61	61
Groceries				541	40	581	581
Grain	1,653		1,653	735	2,647	3,382	5,035
Hardware	1,296	1,973	3,269	146	33	179	3,448
Hay, straw, etc	127		127	886	730	1,616	1,743
Hogs				16	22	38	38
Horses				94	49	143	143
Ice	497		497	552	16	568	1,065
Lumber	1,778	2,651	4,429	434	[a]241,179	241,613	246,042
Logs	35,171		35,171	12	[a]14,031	14,043	49,214
Machinery				90	6	96	96
Oil	26,659		26,659	111	114	225	26,884
Peanuts				40	239	279	279
Potatoes	134		134	88	70	158	292
Railroad ties		28,915	28,915		8,129	8,129	37,044
Salt	5,747		5,747	36		36	5,783
Sand	17,666		17,666				17,666
Unclassified freight	[a]63,914	[a]36,766	100,680	5,540	2,987	8,527	109,207
Vegetables				1	60	61	61
Total	230,297	79,960	310,257	18,649	328,545	342,194	652,451

[a] Partly estimated, no reports being received from some of those to whom application for statistics was twice made.

The amounts reported for 1900 were used, as follows:

Receipts:	Tons.	Shipments:	Tons.
Coal	4,075	Brick	17,417
Cord wood	750	Cord wood	6,900
Fertilizer	600	Lumber	64,000
Grain	88	Logs	7,007
Unclassified freight	4,040	Unclassified freight	5,090
Total	9,553	Total	100,414

Arrival and departure of vessels during the calendar year 1901.

Class.	Port of Richmond, Va.	
	Number.	Tonnage.
Steam, drawing 5 to 16 feet	1,374	1,182,510
Sail, drawing 4 to 17 feet	430	113,846
Barges, etc	1,204	230,536
Total	3,008	1,526,892

Returns for points on James River below Richmond, Va., were too incomplete for report.

REPORT OF MR. SAML. H. YONGE, ASSISTANT ENGINEER.

United States Engineer Office,
Richmond, Va., July 2, 1902.

Colonel: I have the honor to submit my report of operations pertaining to improving James River, Virginia, for the fiscal year ending June 30, 1902.

No channel improvement was carried on, as at the close of the fiscal year of 1901 the available balance of the appropriation of March 3, 1899, was inadequate for carrying on work of sufficient extent to be beneficial and leave an amount large enough to defray the cost of care of plant and repairs to improvement works that might be made necessary by exigencies of freshets and ice gorges.

The small office force, while not employed on the work of protecting Jamestown Island, Virginia, was engaged in finishing incomplete charts, compiling and studying tidal data, and making estimates of the extent and cost of completing the improvement according to the project approved July 5, 1884.

Slight repairs to plant were made to keep it in serviceable condition, consisting of repairing three small boats, the decks of two scows, and the engine, deck, and roof of the tug *Robert Leslie.* New mooring piles for securing the floating plant were driven at the United States Engineer wharf opposite Richmond, Va., to replace others that were becoming unserviceable.

CONDITION OF THE CHANNEL.

The 5¾-mile reach between the lower city line of Richmond and Falling Creek, where the greater part of the improvement work has been carried on, was examined in June, 1902, by sounding 77 sections approximately normal to the channel direction. The soundings show that the channel enlargement effected under the last contract between October, 1899, and June, 1901, viz, on Rocketts reef, Goode rocks section, and the upper third of Richmond bar, has been maintained except at the lower end of the second-named locality, where, as reported in Appendix J, Report of the Chief of Engineers for 1901, a fill-back occurred over an area of about 38,000 square feet almost immediately after the excavation was completed.

For other parts of the reach the conditions are as follows:

Between Jetty B and Goode rocks there have been unimportant changes of scour and fill, the conditions and ruling depth of 16½ feet being the same as reported for June, 1901. One of the changes is on section between Jetties 22 and 29, where in December, 1900, the 18-foot channel was 45 feet wide. The depth for that width is now only 17 feet.

On the lower two-thirds of Richmond Bar the channel is unchanged, with a ruling depth of 18 feet.

On Randolph Flats the depth has been increased 1 to 3½ feet, with a ruling depth of 20 feet.

The above increase in depth probably results from the reduction of area above low water effected by depositing behind the longitudinal dike between Jetties 52 and 58 sand excavated from the channel in carrying on the improvement under the last contract. The deposit of sand was faced with stone to prevent its being washed back into the channel.

The upper half of the middle ground of Warwick reach has been lowered by scour 1 to 3 feet, while the lower half has built up in the middle and deepened on the sides. The ruling depth is 17 feet, or a half foot less than in 1901. These changes are probably temporary.

Between Warwick Reach and Falling Creek the ruling depth of 18 feet and other conditions are practically the same as they were in 1901.

No examination was made of the shoals in the wide reaches of the lower part of the river, which when examined in 1896 showed a depth of about 18 feet. The ruling depth of the entire river, therefore, is 16½ feet, found in the first mile below the lower city line of Richmond, between Jetty B and Goode rocks.

The greatest draft observed of vessels plying James River to Richmond during the fiscal year was 15½ feet.

TIDES AND FRESHETS.

The river was above a normal stage from freshets for about one-third of the fiscal year, during which period there were 11 sharp rises. Seven occurred within slightly less than four months, one of which (that of December 31, 1901) was at the highest elevation since January 2, 1889.

Following is the freshet record for the year:

James River freshets observed at United States Engineer wharf opposite Richmond, Va., from July 1, 1901, to June 30, 1902, inclusive.

Date of crest.	Elevation of crest above gauge zero.	Freshet period, days, approximate.	Date of crest.	Elevation of crest above gauge zero.	Freshet period, days, approximate.
1901.	*Feet.*		1902.	*Feet.*	
August 8	+10.00	4¾	January 23	+ 5.62	8¼
August 15	+11.70	9¼	January 29	+ 6.18	12¼
September 30	+ 6.96	2¼	February 27	+18.90	50
December 17	+14.60	21	March 2	+21.20	
December 31	+25.13		April 9	+ 8.65	
			June 17	+10.00	2¼

The extent of damage to the jetties from freshets was inconsiderable and consisted only of the breaking of a few piles placed at their stream ends as aids to navigation while the jetties are submerged by floods of moderate height. During the two highest freshets the river-bottom plantations between Richmond and Curles Neck, which are protected against ordinary floods by dike embankments, were submerged.

The bank erosion between Richmond and the mouth of the Appomattox River, resulting from the freshets, was probably greater than for many years. From the same cause there also resulted a very marked extension and building up of battures adjacent to the works of rectification.

Another effect of the high and long-continued stage of water is the extensive shoaling in the part of the river between the James River and Kanawha Canal ship lock and the lower city line of Richmond, locally known as Richmond Harbor. This locality forms the lower part of the 1½-mile reach immediately below Richmond Rapids, in which is deposited more or less of the fluvial material brought down the rapids by every freshet. The volume of deposition in the harbor has been greater during the past year than for several preceding years, especially on the left bank below the cofferdam placed by the Wm. R. Trigg Company, near the old canal lock, for the purpose of constructing a lock to connect the basins in the company's yard with James River. The principal part of the shoal consists of a middle ground extending downstream from the cofferdam to Gillies Creek, a distance of about 1,400 feet. Between the shoal and the wharves on the left bank is situated the only available channel, reduced in width to about 120 feet by 9 to 13 feet deep at low water. The above condition has subjected shipowners to more or less inconvenience by causing vessels to go aground while taking on cargo at their berths and in turning to leave port. The city of Richmond has dredged extensively in front of the wharves during the past twelve months without materially improving the condition.

The volume of freshet deposition still remaining in the harbor above the bottom as it was in September, 1899, when the reach was surveyed, is estimated at 89,000 cubic yards. As this office has no record of the quantities dredged by the city of Richmond and private parties, and only the approximate volume dredged in 1901 and 1902 by the former, the total deposition since September, 1899, can only be approximated. It is probably not less than 160,000 cubic yards.

Of the material excavated by the city during the fiscal year, about 30,000 cubic yards were carried down the river on scows and dumped on the sides of the channel near Jetties Nos. 43, 82, and 85.

* * * * * * *

In studying available physical data incidental to proceeding with the work embraced in the project approved July 5, 1884, the fact was developed that the existing area of cross section in Dutch Gap Canal is inadequate to properly pass the discharge during high freshets. The least area of cross section below the plane of mean low water in the canal is 6,326 square feet, while that of the natural channel immediately above is 11,495 square feet. In consequence of the above difference in area the canal becomes a gorged section during freshets. The observed slope in the canal for a freshet having an elevation of 24.28 feet above mean low water at Richmond on April 1, 1886, was 1.74 feet, or 30.6 feet per mile. For another freshet on March 2, 1902, having an elevation of 21.2 feet at the same locality, it was 1.18 feet, or 20.76 feet per mile.

The above-described slope condition has probably grown worse from year to year on account of the natural deposition in the old river bed cut off by the canal. The cut-off channel is now filled to mean low water about 1¾ miles below the canal.

In consequence of the contracted section in the canal the plane of the water surface in the river above it is raised during freshets. From the same cause scour of the canal's bluff sides, both above and below mean low water, has occurred, especially on the left side. This culminated on May 13, 1902, in a bluff slide of considerable proportions. In the slide the toe of the left bluff, for a distance of 400 feet, moved forward from 10 to 55 feet, while the main portion of the bluff behind sunk from 11 to 23 feet. The maximum width of the sunken portion of the bluff is 125 feet, its area about a half acre, and the displaced volume about 30,000 cubic yards.

Although the area of the channel was reduced about 10 per cent by the slide, the part of the section used for navigation was not encroached on sufficiently to materially impair it.

Several similar slides of the same bluff have occurred in former years, but none so extensive as the recent one. The necessity of grading the almost vertical face of the bluff and of placing a retaining bulkhead at its toe, about the level of mean low water, to prevent a similar recurrence is apparent.

The channel of Dutch Gap Canal was sounded, and cross sections made of left bank shortly after the bluff slide in May to obtain data on which to base a project for improving the canal reach.

The wooden steamship *Yemassee*, of the Clyde Line, while entering Dutch Gap Canal bound upstream, on August 15, 1901, was thrown by a strong cross current against the right bank and sustained damages which made docking the ship necessary.

Very respectfully, your obedient servant,

SAML. H. YONGE,
Assistant Engineer.

Lieut. Col. CHAS. J. ALLEN,
Corps of Engineers, U. S. Army.

K 15.

PROTECTION OF JAMESTOWN ISLAND, VIRGINIA.

For full historical sketch see pages 1736–1738, Appendix L, Annual Report of the Chief of Engineers for 1900.

A contract for the protection work of the bank was made December 6, 1900, with Lane Bros. & Co., of Esmont, Va., the work to commence on or before February 2, 1901, and to be completed on or before August 2, 1901. The contract operations began February 1, 1901, and were completed November 16, 1901.

Two appropriations have been made for this work—one in 1894 of $10,000, and the other of $15,000 in 1896. Neither appropriation was preceded, so far as the records show, by any official report or estimate, and the wishes of Congress in regard to the extent of protection are not known.

With this are extracts from the report of Assistant Engineer S. H. Yonge, showing work of the fiscal year.

Money statement.

July 1, 1901, balance unexpended	$14,465.55
June 30, 1902, amount expended during fiscal year	14,143.40
July 1, 1902, balance unexpended	322.15

CONTRACT IN FORCE.

Contractors: Lane Bros. & Co., of Esmont, Va., for constructing shore protection.
Amount: 1,350 linear feet, more or less.
Estimate amount of contract: $14,000.
Date: December 6, 1900.
Approved: January 2, 1901.
Date for commencement: February 2, 1901.
Date for completion: August 2, 1901; extended to November 2, 1901. The contractors were allowed a further reasonable time for completing the work.

REPORT OF MR. SAML. H. YONGE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Richmond, Va., July 2, 1902.

COLONEL: I have the honor to submit the following report of operations pertaining to the work of protecting Jamestown Island, Va., from the encroachments of James River, for the fiscal year ending June 30, 1902:

The operations consisted of completing 1,348 linear feet of revetment, begun February 1, 1901, under contract with Lane Bros. & Co., dated December 6, 1900; approved January 2, 1901.

The work extends from the northwest corner of the island 62 feet along its northern shore and 1,248 feet along the contiguous western shore.

Although considerable progress had been made with different branches of the work, at the close of the last fiscal year none was completed, and the placing of the revetment had not been begun.

The time for completing the contract having expired August 2, 1901, work was proceeded with after that date under a three months' extension, terminating November 2, 1901, granted the contractors at their request. Being still incomplete on the latter date and the contractors having applied for a further extension, they were allowed a reasonable time for completing the work. The contract was completed November 16, 1901.

The revetment replaces protection work of large, irregular stones placed in 1895, between which the waves penetrated, their suck producing recession of the shore of from 2 to 25 feet. It consists of a concrete block wall, extending from mean low water to 8.42 feet above that plane, inclined landward about 24 degrees from the vertical, and backed by 12 inches of broken stone laid on the sloped bank of the island; or where that was at a too low elevation to carry the wall to the required height, on clay embankment raised for the purpose. The toe of the wall is buttressed by a timber structure, in which a closely driven line of sheet piling, attached to wales bolted to round piles, serves as a shield against undermining by wave impact and subsidence of the wall where it crosses pockets of quicksand.

The wall blocks are 8 inches thick, 14 to 18 inches wide, and, with the exception of a few at the downstream end, which are shorter, from 4 to 7.56 feet long. The blocks of each course are of uniform width, breaking joints from 1 to 3 feet with those of the adjacent courses above and below. The joint widths seldom exceed one-half inch, and average three-eighths inch. All blocks excepting those of the coping course were molded in wooden boxes with movable sides and ends. The coping-course blocks were molded in place, pasteboard shims being used to separate them into lengths of about 4 feet, and also from the adjoining course below. The above device, which was adopted to prevent cracking from expansion and contraction of the concrete and bank shrinkage, has answered its purpose satisfactorily. Soft steel cramps, 1⅛ inches square, leaded in holes molded near the ends of coping blocks, secure the blocks against removal.

The concrete was formed of one part Lehigh Portland cement, three parts sand and five parts granite, gneiss or trap rock, all by measure. The limiting dimensions of the concrete stone were one-half inch and 2½ inches. The ingredients were hand-mixed, dry, and only sufficient water added to cause slight flushing at the surface under ramming without quaking. The box molds were frequently scraped, and as a rule, moistened before molding. Although great care was exercised to produce solid blocks with smooth surfaces, small voids appeared in about 36 per cent of the blocks. The voids were filled by grouting with Portland cement mortar, composed of one part cement to two sand. The repairs were covered with wet cloth and protected from the sun for several days.

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The blocks were bedded with a firm bearing on the backing, and settled by ramming, their top surfaces being brought approximately to the plane of the wall.

The block work of the two sections of revetment on the northern and western shores, which diverge about 90 degrees, is united by 262 square feet of monolithic concrete, made in place under the same specifications as the blocks. The monolith is connected with the end blocks of each course contiguous to it by steel cramps in the same manner as described for the coping blocks.

The stone backing was placed in two layers 6 inches thick. The limiting dimensions of stones of the lower layer are 1 and 1½ inches, and of the upper layer 1½ and 2½ inches. The backing was rammed thoroughly and brought to an approximately true surface.

The embankment consists of brick clay built up in layers, compacted by moistening and ramming. Its exterior slope was carried 0.08 feet above the required grade, to allow for the sinking into it of the stone backing under ramming.

The buttress supporting the toe of the block work and shielding it from undermining is composed entirely of oak. It consists of a line of white oak piles, 10 feet from centers, driven to 15 feet below mean low water, having bolted to their shore sides a continuous line of 6 by 8 inch wales. Three-inch sheet piling, driven 12 feet below mean low water, is spiked to the wale, and on its shore face is bolted a 3 by 8 inch string piece, whose upper surface is in the plane of mean low water. Against the string piece is laid the bottom course of wall blocks.

The buttress was constructed to conform to an approximately even line, to which the coping course, as finally laid, is parallel. Three changes in direction of the natural shore line made the introduction of the curves necessary. These have radii of 1,000 feet, two being convex and one concave.

In conducting the operations of the preceding fiscal year, the contractors depended on frail earth banquettes for excluding water from the excavation made to receive the concrete blocks and stone backing of the part of the revetment below and within the tidal range. On account of the frequent breaking of these banks by waves, the work was constantly interrupted and greatly delayed. In July the use of a movable plank coffer-dam was begun, after which fair progress was made with the work.

The placing of blocks was begun July 30. The best day's work in this branch consisted of placing 219 blocks.

At the lower end of the revetment the buttress was turned shoreward 90 degrees, carried into the natural bank, and, to protect it against undermining, surrounded by an apron of stone riprap.

Following are the quantities of the different classes of work involved in the construction of the revetment:

(1)	Removing stone protection of 1895 from 1,342 linear feet of bank, cubic yards	605.24
(2)	One hundred and forty round oak piles, driven and cut off . linear feet..	2,144.50
(3)	Six by 8 inch white oak wales, framed and bolted to round piles, feet B. M	5,867.79
(4)	Three-inch oak sheet piling, driven, sawed off and attached to wales, feet B. M	48,203.75
(5)	Three by 8 inch white oak string pieces, framed and bolted through sheet piling and wale feet B.M..	2,746.58
(6)	Grading, including embankment only cubic yards..	1,912.36
(7)	Breaking stone protection of 1895 and placing product on embankment cubic yards..	706.683
(8)	Broken stone backing furnished by contractor in place do....	595.32
(9)	Concrete blocks, assorted sizes, laid in place, 5,185 do....	764.508
(10)	Monolithic concrete in place do....	6.48
(11)	Steel cramps, leaded in place cramps..	360
(12)	Stone riprap in place cubic yards..	5.25

The revetment was carefully examined several times since its construction and found in perfect condition.

In March, 1902, the interior slope of the embankment was sowed in grass.

During the period of operations of the fiscal year work was interrupted by high tides and rain on 23 days, and by the failure of the contractor to have on hand the necessary materials 9 days.

Inspection of the work was performed by Mr. L. A. Guy, inspector, assisted by Mr. W. B. Haynes, subinspector, to both of whom great credit is due for satisfactory results attained.

Very respectfully, your obedient servant,

SAML. H. YONGE,
Assistant Engineer.

Lieut. Col. CHAS. J. ALLEN,
Corps of Engineers, United States Army.

K 16.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

Sunken raft in Piankatank River, Virginia.—During a storm in the fall of 1900 a section of a raft of long piles became tangled up and was abandoned in deep water in the Piankatank River.

The obstruction was reported to this office December 12, 1901, and inquiry was at once made as to the same. On December 21, 1901, an allotment of $50 was made from the indefinite appropriation for removing sunken vessels or craft obstructing or endangering navigation to defray the expenses of an examination, which was made January 7, 1902, and a report thereon submitted January 22, 1902. It was found that the raft had broken up and most of the piles had drifted ashore, while others, being water-logged, had sunk to the bottom, carrying along with them a number of light piles, which, being fastened only at one end, had sufficient buoyancy remaining to cause their free ends to project above the surface. At the time of the examination all of these except two had either broken away or become water-logged and sunk. The piles were then worm-eaten. A further allotment of $100 was asked to provide for the removal of the obstruction, and this allotment was made January 27, 1902.

As soon as the river was free of ice a large sailing canoe was procured, and after ascertaining that the lower ends of the piles were securely held, their free ends were lifted as far as possible and loaded with 600 to 800 pounds of sand sewn up in several thicknesses of heavy burlap sacks, which were securely lashed to the piles with rope. The piles were then allowed to sink to the bottom, in about 20 feet of water. The bags will undoubtedly hold until the piles become water-logged, covered with mud, or destroyed by the teredo. It was not considered advisable at the time to attempt to remove the piles by means of dynamite.

The entire cost of removing the obstruction, including preliminary examination, labor, and contingencies, was $114.80. The work was done by hired labor.

Wreck of bugeye Daisy in Carters Creek, Virginia.—On April 23, 1902, this office was informed that this vessel had been sunk in Carters Creek, endangering navigation.

On May 1, 1902, an allotment of $50 was made from the indefinite appropriation for removing sunken vessels or craft obstructing or endangering navigation to defray the expense of an examination. The examination, made May 23, 1902, showed that the wreck lay in the entrance to the western branch of Carters Creek in a depth of about 10 feet of water. The wreck is approximately 40 feet long, 10 feet beam, and 5 or 6 feet depth of hull. The bow is covered by about 1.5 feet of water at low tide, and the stern, having settled deeper in the mud, is 4 or 5 feet below the low-water surface. The boat, which was practically worthless, drifted away from her moorings and sank one night during the fall of 1901.

On June 2, 1902, a report upon the results of the examination was made to the Chief of Engineers and the removal of the wreck recommended, the estimated cost of removal being $200. This recommendation was approved, and on June 5, 1902, an allotment of $200 for removing the wreck was made from the indefinite appropriation for removing sunken vessels or craft obstructing or endangering navigation.

It is expected that the wreck will be removed early in the ensuing fiscal year by the United States snag boat.

APPENDIX L.

IMPROVEMENT OF NORFOLK HARBOR, VIRGINIA, AND ITS APPROACHES, AND OF WATERWAYS AND HARBORS IN SOUTHEASTERN VIRGINIA AND NORTHEASTERN NORTH CAROLINA.

REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Harbor at Norfolk and its approaches, Virginia.
2. Western Branch of Elizabeth River, Virginia.
3. Hampton Roads, Virginia.
4. Nansemond River, Virginia.
5. Pagan River, Virginia.
6. Appomattox River, Virginia.
7. Harbor at Cape Charles City, Virginia.
8. Nandua Creek, Virginia.
9. Waterway from Norfolk, Virginia, to the sounds of North Carolina.
10. Inland water route from Norfolk, Virginia, to Albemarle Sound, North Carolina, through Currituck Sound.
11. Edenton Bay, North Carolina.
12. Roanoke River, North Carolina.
13. Removing sunken vessels or craft obstructing or endangering navigation.

HARBOR LINES.

14. Pasquotank River at Elizabeth City, North Carolina.

Engineer Office, U. S. Army,
Norfolk, Va., July 18, 1902.

General: I have the honor to transmit herewith my annual report upon the works of river and harbor improvement in my charge during the fiscal year ended June 30, 1902.

Very respectfully, your obedient servant,

James B. Quinn,
Major, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

L 1.

IMPROVEMENT OF HARBOR AT NORFOLK AND ITS APPROACHES, VIRGINIA.

A survey was made of Smith Creek, which is considered a part of the harbor, for the purpose of defining lines to limit the erection of wharves and bulkheads on said creek, the cost of which is represented by the expenditures reported for the fiscal year ended June 30, 1902.

The funds available, and the amount estimated for completion, will be applied to dredging in removing the shoal in front of the wharves at Pinner Point, in cutting away 400 feet of Hospital Point, and in excavating at Berkley Flats.

Money statement.

July 1, 1901, balance unexpended	$3,467.23
Amount appropriated by river and harbor act approved June 13, 1902	30,000.00
	33,467.23
June 30, 1902, amount expended during fiscal year	214.28
July 1, 1902, balance unexpended	33,252.95
Amount (estimated) required for completion of existing project	240,731.56
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	240,731.56
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Improving harbor at Norfolk, Va.:	
August 14, 1876	$35,000.00
June 18, 1878	50,000.00
March 3, 1879	75,000.00
June 14, 1880	50,000.00
March 3, 1881	75,000.00
August 2, 1882	75,000.00
July 5, 1884	25,000.00
August 5, 1886	50,000.00
August 11, 1888	50,000.00
September 19, 1890	150,000.00
July 13, 1892	150,000.00
August 18, 1894	100,000.00
June 3, 1896	100,000.00
June 13, 1902	30,000.00
Improving Elizabeth River, Virginia:	
July 7, 1898	360,000.00
	1,375,000.00
Amount turned into surplus fund of the Treasury from appropriation of July 7, 1898	483.58
	1,374,516.42

COMMERCIAL STATISTICS.

The following statistics relative to the commerce of the harbor at Norfolk, Va., during the calendar year 1901 were compiled from statements furnished by parties making shipments over this waterway:

Articles.	Amount.	Value.
	Tons.	
Fertilizer	189,443	$2,876,380
Brick	27,400	67,750
Shingles	20,000	114,400
Coal	2,199,552	6,681,458
Shells	19,000	15,000
Lumber	518,308	3,403,986
Logs	257,803	469,274
Grain	71,588	1,787,108
Oysters and fish	57,500	575,000
Miscellaneous	4,400,762	435,028,480
Total	7,761,356	451,018,751

Regular lines of tansportation June 30, 1902.—There are several lines of foreign steamers that ply here regularly. The Old Dominion Steamship Company maintains daily lines between New York, Newport News, Smithfield, Richmond, and Suffolk; the Merchants and Miners' Transportation Company operates a daily line between Boston, Providence, Newport News, and Norfolk. In addition, there are two daily lines to Baltimore and one to Washington. The largest steamer that loaded in the harbor during the year 1901 was the British steamer *Maplemore*, 12,000 tons capacity, with a draft of 29 feet 2 inches. This steamer, after loading, was compelled to wait for extreme high tide to go out. The largest sailing vessel loaded here for same year was the American schooner *Eleanor Percy*, 5,500 tons capacity, with a draft of 27 feet 6 inches.

L 2.

IMPROVEMENT OF WESTERN BRANCH OF ELIZABETH RIVER, VIRGINIA.

No work was done during the fiscal year, other than office work.

The balance of funds is being retained for a survey, which should be made to determine whether or not shoaling has taken place in the improved channel.

Money statement.

July 1, 1901, balance unexpended	$373.77
June 30, 1902, amount expended during fiscal year	40.50
July 1, 1902, balance unexpended	333.27

APPROPRIATION.

June 3, 1896	$45,000

COMMERCIAL STATISTICS.

The following statistics, indicating the commerce of the river during the calendar year 1901, were compiled from statements furnished by shippers:

Articles.	Amount.	Value.
	Tons.	
Copper ore	29,000	$135,000
Logs	10,000	20,000
Manufactured lumber	635,220	3,186,100
Merchandise and produce	708,886	7,347,850
Total	1,383,106	10,688,950

Vessels.

Class.	Number.	Average draft.
		Feet.
Steam	312	12½
Sail	188	7
Barges	7,332	10½
Total	7,782	

Regular lines of transportation June 30, 1902.—A ferry, operating one boat every two hours during the daytime between West Norfolk and Norfolk, Va., is the only regular line. The New York, Philadelphia and Norfolk Railroad Company has four tugs and six barges in service, transporting freight between Port Norfolk, Cape Charles, and Norfolk, Va.

L 3.

IMPROVEMENT OF HAMPTON ROADS, VIRGINIA.

This is a new work, the first appropriation for which was made by the act of June 13, 1902.

No work has been done, but it is contemplated to provide the channel toward which the funds were appropriated, as early as practicable, under a continuing contract.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902	$10,000.00
July 1, 1902, balance unexpended	10,000.00
Amount (estimated) required for completion of existing project	215,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	215,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATION.

June 13, 1902	$10,000

COMMERCIAL STATISTICS.

The following statistics were compiled from statements of the shippers at Newport News, Va., and indicate the traffic by way of Hampton Roads, Virginia, during the calendar year 1901:

Articles.		Amount.	Value.
Cattle	number	28,847	$2,884,700
Grain	tons	277,598	6,290,341
Coal	do	2,399,803	7,199,409
Cotton	do	9,562	1,651,746
Logs	do	10,022	501,150
Lumber	do	65,794	1,858,269
Miscellaneous	do	973,664	26,469,281
Total		3,736,443	46,854,896

Vessels.

Class.	Number.	Average draft.	Average tonnage.
		Feet.	
Steam	7,115	18 to 27	2,000 to 5,000
Sail	1,066	22 to 28	1,100 to 4,500
Total	8,181		

Regular lines of transportation, June 30, 1902.—There are four foreign lines of steamers that run regularly to Newport News, Va., from foreign ports; two regular lines of coastwise steamers, and two lines of steamers making two round trips daily between Norfolk and Newport News, Va.

L 4.

IMPROVEMENT OF NANSEMOND RIVER, VIRGINIA.

No work was done or expenditures made during the fiscal year.

Money statement.

July 1, 1901, balance unexpended	$9,869.94
July 1, 1902, balance unexpended	9,869.94
July 1, 1902, outstanding liabilities	9.75
July 1, 1902, balance available	9,860.19
Amount (estimated) required for completion of existing project	1,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	1,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

March 3, 1873	$15,000	July 13, 1892	$10,000
March 23, 1874	10,000	August 18, 1894	10,000
March 3, 1875	5,000	June 3, 1896	5,000
March 14, 1876	5,000	March 3, 1899	5,000
June 18, 1878	2,000		
August 11, 1888	10,000	Total	87,000
September 19, 1890	10,000		

COMMERCIAL STATISTICS

The following statistics relative to the commerce of Nansemond River, Virginia, during the calendar year 1901, were compiled from statements furnished by parties making shipments over this waterway:

Articles.	Amount.	Value.
	Tons.	
Lumber	52,854	$372,201
Produce	40,000	1,000,000
Fertilizer	10,000	200,000
Oysters	4,000	50,000
Coal	3,100	15,500
Miscellaneous	9,938	99,380
Total	119,892	1,737,081

Vessels.

Class.	Number.	Average draft.	Average tonnage.
		Feet.	
Steam	127	7½	115
Sail	125	9½	250
Barges	12	5	50
Total	254		

Regular lines of transportation June 30, 1902.—There is only one line of steamers on this river, making daily trips between Suffolk and Norfolk, Va., owned and operated by the Old Dominion Steamship Company.

L 5.

IMPROVEMENT OF PAGAN RIVER, VIRGINIA.

The improvement of this river was revived under an appropriation of $10,870 in the act of June 13, 1902. No operations were carried on during the fiscal year.

It is proposed to apply the funds available toward securing the channel outlined in the report of the survey of the stream to be found on pages 1477–1478, Annual Report of the Chief of Engineers, 1901.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902	$10,870.00
July 1, 1902, balance unexpended	10,870.00
Amount (estimated) required for completion of existing project	18,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	18,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

June 14, 1880	$5,000
March 3, 1881	5,000
June 13, 1902	10,870
Total	20.870

COMMERCIAL STATISTICS.

The following statistics represent the commerce of Pagan River, Virginia, during the calendar year 1901:

Articles.	Amount.	Value.
	Tons.	
Truck and produce	6,978	$172,100
Brick	5,400	14,700
Oysters and fish	50,000	400,000
Fertilizer	2,405	37,999
Coal	2,150	9,350
Lumber	5,100	46,500
Miscellaneous	86,025	360,250
Total	108,058	1,040,899

Vessels.

Class.	Number.	Average draft.	Average tonnage.
		Feet.	
Steam	2	6	150
Sail	150	3 to 8	15 to 300
Total	152		

Regular lines of transportation, June 30, 1902.—The Old Dominion Steamship Company has two steamers making daily round trips each between Norfolk and Smithfield, Va.

L 6.

IMPROVEMENT OF APPOMATTOX RIVER, VIRGINIA.

No operations were carried on during the fiscal year.

The amounts appropriated for this improvement will be applied—the $7,500 to removing shoals in the channel between Stake Island and Petersburg, and the $25,000 to the acquirement of land needed in carrying out the plan of diverting the freshet water. The amounts recommended are for annual maintenance under approved project, and for work which will be performed under the diversion scheme.

Money statement.

July 1, 1901, balance unexpended		$21.97
Amount appropriated by river and harbor act approved June 13, 1902		32,500.00
		32,521.97
June 30, 1902, amount expended during fiscal year		11.34
July 1, 1902, balance unexpended		32,510.63
July 1, 1902, outstanding liabilities		9.63
July 1, 1902, balance available		32,501.00
Amount (estimated) required for completion of existing project		223,090.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$175,000.00	
For maintenance of improvement	10,000.00	
		185,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

March 3, 1871	$50,000	July 5, 1884	$25,000
June 10, 1872	40,000	August 5, 1886	18,750
March 3, 1873	30,000	August 11, 1888	15,000
June 23, 1874	30,000	September 19, 1890	15,000
March 3, 1875	30,000	July 13, 1892	15,080
August 14, 1876	30,000	August 18, 1894	5,000
June 18, 1878	30,000	June 3, 1896	5,000
March 3, 1879	20,000	March 3, 1899	5,000
June 14, 1880	20,000	June 13, 1902	32,500
March 3, 1881	20,000		
August 2, 1882	35,000	Total	471,330

COMMERCIAL STATISTICS.

The following statistics relative to the commerce of the Appomattox River, Virginia, during the calendar year 1901 were compiled from statements furnished by shippers:

Articles.	Amount.	Value.
	Tons.	
Railroad ties	8,919	$44,596
Cordwood	9,020	22,867
Lumber	68,210	319,010
Machinery	1,700	7,650
Produce	1,362	134,141
Fertilizer	8,185	79,350
Coal	4,901	28,079
Grain	530	10,818
General merchandise	42,682	213,410
Total	145,509	859,921

Vessels.

Class.	Number.
Steam	954
Sail	302
Barges	205
Total	1,461

Regular lines of transportation June 30, 1902.—Petersburg and Norfolk Steamboat Line, one passenger and freight steamer, making three round trips per week between Norfolk and Petersburg, Virginia.

* * * * * * *

L 7.

IMPROVEMENT OF HARBOR AT CAPE CHARLES CITY, VIRGINIA.

No work was done or expenditures made during the fiscal year 1902. The appropriation in the act of June 13, 1902, will be applied to dredging, as the entrance channel has shoaled considerably and it is essential that it be redredged in order to give relief to commerce.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$292.74
Amount appropriated by river and harbor act approved June 13, 1902	20,000.00
July 1, 1902, balance unexpended	20,292.74
July 1, 1902, outstanding liabilities	5.25
July 1, 1902, balance available	20,287.49
Amount (estimated) required for completion of existing project	67,340.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	40,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

September 19, 1890	$25,000
July 13, 1892	10,000
March 3, 1899	20,000
June 13, 1902	20,000
Total	75,000

COMMERCIAL STATISTICS.

The following statement represents the commerce of the harbor at Cape Charles City, Va., during the calendar year 1901, and was prepared from statements supplied by lines and individuals handling the freight:

Articles.	Amount.	Value.
	Tons.	
Oysters and fish	2,500	$21,750
Ice	1,500	7,500
Lumber	250	10,000
Brick	5,000	16,000
Fertilizer	50,000	500,000
Miscellaneous	881,396	8,813,960
Total	940,646	9,369,210

Vessels.

Class.	Number.	Average draft.	Average tonnage.	Remarks.
		Feet.		
Steam	10	9	400	
Sail	25	6	100	
Barges	5	7.6	....	Transfer barges or car floats.

Regular lines of transportation, June 30, 1902.—The New York, Philadelphia and Norfolk Railroad Company have three passenger steamers on this line making one round trip per day each between Cape Charles City, Old Point, and Norfolk, Va.

L 8.

IMPROVEMENT OF NANDUA CREEK, VIRGINIA.

No work was performed or expenditures made during the fiscal year 1902.

This work was transferred on June 30, 1902, to the Washington, D. C., district.

Money statement.

July 1, 1901, balance unexpended	$28.68
July 1, 1902, balance unexpended	28.68

APPROPRIATIONS.

June 3, 1896	$3,000
March 3, 1899	3,000
Total	6,000

COMMERCIAL STATISTICS.

The following statistics relative to the commerce of Nandua Creek, Virginia, during the calendar year 1901 were furnished by Mr. J. C. Boggs, of Nandua, Va.:

Articles.	Amount.	Value.
	Tons.	
Fish, oysters, produce, and merchandise	4,188	$164,578
Oyster shells and lumber	950	37,000
Logs		7,800
Total	5,138	209,378

Vessels.

Class.	Number.	Average draft.	Average tonnage.
		Feet.	
Steam	2	7	791
Sail	10	6	30
Rafts	2	2	
Total	14		

L 9.

IMPROVEMENT OF WATERWAY FROM NORFOLK, VIRGINIA, TO THE SOUNDS OF NORTH CAROLINA.

During the fiscal year ended June 30, 1902, the dredging and protection of the banks of Turners Cut and the removal of points in the Pasquotank River, North Carolina, under the continuing contract of August 1, 1899, with the Virginia Dredging Company were in progress. All work covered by the contract above mentioned was satisfactorily completed March 18, 1902, and the contract closed.

The total yardage removed in Turners Cut during the fiscal year was 263,562. The distance over which excavation was made was 10,750 feet, 4,950 feet of which had been dredged to a depth of 8 feet at mean low water during the previous fiscal year, the balance of the distance (5,800 feet) being excavated through the original cross section. The width of cutting was on the average 45 feet, and the depth obtained 10 feet at mean low water.

In addition to the dredging, 17,775 linear feet of sheet-piling with brush filling in rear were driven at various points on both sides of Turners Cut where it was considered requisite to prevent the sandy banks from falling into the channel, or being scoured by the wash from swells of passing steam craft.

On the Pasquotank River section of this improvement the abrupt bends were remedied by cutting off eight of the projecting points in the upper portion of the river. This necessitated the excavation of 36,266 cubic yards of material.

After the continuing contract was closed, a balance of $14,378 remained unexpended. Considerable shoaling in the channel in Deep

Creek had occurred since dredging was done there, and application was made for authority to expend a portion of the unexpended balance in redredging the channel where necessary between the mouth and a point 8,500 feet above, which it was estimated would require the removal of about 45,000 cubic yards, place measurement, of material. The authority was granted for this work, and public notice issued for proposals to be received until 12 o'clock noon, June 16, 1902, and then opened. Only one bid was tendered under the invitation, the price named being 19 cents per cubic yard, place measurement. The acceptance of that figure was authorized June 23, 1902, and a contract with the successful bidder, which was the Sanford & Brooks Company, will be executed early in July, 1902.

The funds available will be applied to dredging Deep Creek, Virginia. An appropriation of $5,000 for maintenance is recommended to be expended in dredging Turners Cut and Deep Creek, on which sections some slight shoaling is apprehended.

Money statement.

July 1, 1901, balance unexpended	$139,345.41
June 30, 1902, amount expended during fiscal year	125,994.16
July 1, 1902, balance unexpended	13,351.25
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	5,000.00

APPROPRIATIONS.

March 3, 1899	$25,000
Act June 6, 1900	200,000
Act March 3, 1901	29,870
Total	254,870

ABSTRACT OF CONTRACT IN FORCE.

Contractor: Virginia Dredging Company.
Date of approval: September 6, 1899.
Date of beginning work: September 11, 1899.
Date of expiration: March 18, 1902.

Rates: Dredging Deep Creek section, 15 cents per cubic yard, scow measurement. Turners Cut section: Dredging, 25 cents per cubic yard, measured on the bank; sheet-piling, $2 per linear foot; brush protection, $1.50 per linear foot. Pasquotank River, North Carolina: Dredging shipyard bar, 15 cents per cubic yard, scow measurement; projecting points, 27 cents per cubic yard, measured on the bank. Croatan Sound, North Carolina: Dredging, 30 cents per cubic yard, scow measurement.

COMMERCIAL STATISTICS.

The following statistics were compiled from a statement furnished by Mr. S. W. Gary, superintendent of the Lake Drummond Canal and Water Company, and indicate the traffic through the Dismal Swamp Canal, Virginia and North Carolina, for eleven months of the calendar year 1901, the canal having been closed during one month of that year:

Articles.	Amount.	Value.
	Tons.	
Lumber	129,471	$784,825
Shingles	2,367	23,671
Coal	5,803	17,409
Logs	36,816	81,912
Grain	2,285	40,846
Miscellaneous	37,521	536,746
Total	214,263	1,485,409

Vessels.

Class.	Number.	Average draft.	Average tonnage.
		Feet.	
Steam	1,230	8	36
Sail	699	7	58
Barges	539	9	268
Lighters	485	3	....
Rafts (average number of feet, log measurement, 35,963 each)	16	....	....
Yachts	50	....	....
Dredges	11	....	....
Scows	9	....	....
Houseboats	1	8	106
Revenue cutters	2	....	....
Pontoons	3	....	....
Pile drivers	4	....	....
Total	3,049	....	....

Regular lines of transportation, June 30, 1902.—There is a regular line of passenger and freight steamers that ply through this canal, which is owned and operated by the Norfolk and Southern Railroad Company, making tri-weekly trips between Norfolk, Va., and Elizabeth City, N. C.

L 10.

IMPROVEMENT OF INLAND WATER ROUTE FROM NORFOLK, VIRGINIA, TO ALBEMARLE SOUND, NORTH CAROLINA, THROUGH CURRITUCK SOUND.

The United States snag boat *Roanoke*, equipped as a dredge, was employed on this improvement during July to October, 1901, in the excavation of a cut through North River bar to a depth of 10 feet at mean low water. The material removed amounted to 3,608 cubic yards, and resulted in a channel of the depth above mentioned over a width of 30 feet for a distance of 1,184 feet.

After the work described above had been performed it became necessary to detach the snag boat to remove channel obstructions in the Roanoke River, and as a small balance of funds was still available for further dredging, the expenditure of the amount ($2,000) was arranged for in excavating a second cut through North River bar, under a written offer made by the Albemarle and Chesapeake Canal Company to do the dredging at 65 cents per cubic yard, scow measurement.

The Albemarle and Chesapeake Canal Company put their dredge and two scows with a tugboat at work on November 20, 1901, and this plant continued, with very favorable weather, until December 24, 1901. In this time 3,013 cubic yards of material were removed and deposited. The area dredged was 1,194 feet by 26 feet to a depth of 9½ feet at mean low water.

With the appropriation of June 13, 1902, it is contemplated to dredge at North River bar, remove sunken logs and other obstructions, and maintain the channel.

Money statement.

July 1, 1901, balance unexpended	$5,056.46
Amount appropriated by river and harbor act approved June 13, 1902	23,400.00
	28,456.46
June 30, 1902, amount expended during fiscal year	5,056.14
July 1, 1902, balance unexpended	23,400.32
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement in addition to the balance unexpended July 1, 1902 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	2,000.00

APPROPRIATIONS.

For southern branch Elizabeth River, Virginia:		
March 3, 1873	$15,000	
June 23, 1874	10,000	
March 3, 1875	5,000	
August 14, 1876	5,000	
June 18, 1878	5,000	
		$40,000.00
For North Landing River, Virginia and North Carolina:		
March 3, 1879	25,000	
June 14, 1880	15,000	
March 3, 1881	7,500	
August 2, 1882	8,000	
		55,500.00
For Currituck Sound, Coinjock Bay, and North River Bar, North Carolina:		
June 18, 1878	20,000	
March 3, 1879	25,000	
June 14, 1880	25,000	
March 3, 1881	30,000	
August 2, 1882	20,000	
July 5, 1884	5,000	
August 5, 1886	10,000	
August 11, 1888	7,500	
		142,500.00
For inland water route, etc.:		
September 19, 1890	10,000.00	
July 13, 1892	9,000.00	
August 18, 1894	10,000.00	
June 3, 1896	10,000.00	
March 3, 1899	8,000.00	
June 13, 1902	23,400.00	
		70,400.00
Total		308,400.00
Amount received from sale of property to other works		2,169.69
Aggregate		310,569.69

COMMERCIAL STATISTICS.

The following statistics relative to the commerce of the inland water route from Norfolk Harbor, Virginia, to Albemarle Sound, North Carolina, during the calendar year 1901, were compiled from statements furnished by the Albemarle and Chesapeake Canal Company, and shippers along the route:

Articles.	Amount.	Value.
	Tons.	
Lumber	162,471	$1,099,542
Shingles	8,532	116,155
Wood	1,135	12,540
Railroad ties	100	9,645
Miscellaneous	38,026	809,514
Total	210,264	2,047,396

Vessels.

Class.	Number.	Average draft.	Average tonnage.	Total tonnage.
		Feet.		
Steam	2,226	3 to 9	63	139,898
Sail	795	2 to 9	49	38,994
Barges	798	2 to 8½	193	154,001
Lighters		2 to 8		
Rafts	341			
Total	4,160			332,888

L 11.

IMPROVEMENT OF EDENTON BAY, NORTH CAROLINA.

No actual operations were in progress during the fiscal year 1902. The expenditures were made in connection with an inspection and examination of the channel.

Money statement.

July 1, 1901, balance unexpended	$178.08
Amount appropriated by river and harbor act approved June 13, 1902	6,000.00
	6,178.08
June 30, 1902, amount expended during fiscal year	37.45
July 1, 1902, balance unexpended	6,140.63

APPROPRIATIONS.

By act approved—	
June 18, 1878	$4,000
March 3, 1879	1,000
July 5, 1884	10,000
August 5, 1886	2,000
June 13, 1902	6,000
Total	23,000

COMMERCIAL STATISTICS.

The following statistics relative to the commerce of Edenton Bay, North Carolina, during the calendar year 1901 were compiled from statements furnished by transportation lines handling the freight:

Articles.	Amount.	Value.
	Tons.	
Lumber	45,000	$175,000
General merchandise, produce, and fish	167,950	1,261,514
Total	212,950	1,436,514

Vessels.

Steam		8
Average draft	feet..	7½
Average tonnage		125

Regular lines of transportation June 30, 1902.—Norfolk and Southern Railroad Company, 3 steamers daily; Albemarle Steam Navigation Company, 3 steamers twice a week.

L 12.

IMPROVEMENT OF ROANOKE RIVER, NORTH CAROLINA.

The snag boat *Roanoke* was in service on the river between November 30, 1901, and May 15, 1902. The work was confined to the removal of channel obstructions between Plymouth and Weldon, N. C., and consisted in taking out 45 trees, 21 logs, and 1 stump, and the trimming of 14 trees which overhung the channel.

With the balance of funds on hand the dredging of the channel near Weldon and the maintenance of an unobstructed channel are contemplated.

Money statement.

July 1, 1901, balance unexpended	$15,781.11
June 30, 1902, amount expended during fiscal year	5,175.34
July 1, 1902, balance unexpended	10,605.77
Amount (estimated) required for completion of existing project	41,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	21,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

March 3, 1871	$20,000	July 13, 1892	$50,000
June 10, 1872	10,000	August 18, 1894	30,000
March 3, 1873	10,000	June 3, 1896	10,000
June 23, 1874	5,000		
August 2, 1882	5,000	Total	228,000
July 5, 1884	3,000	Amount received from sale of property to other works	1,338
August 5, 1886	20,000		
August 11, 1888	40,000		
September 19, 1890	25,000	Aggregate	229,338

COMMERCIAL STATISTICS.

The following statistics show the commerce of the Roanoke River, North Carolina, during the calendar year 1901, and were compiled from statements obtained from the shippers:

Articles.	Amount.	Value.
	Tons.	
Fish	3,400	$54,250
Lumber	103,026	515,130
Logs	77,200	193,000
Shingles	22,200	168,710
Merchandise and produce	20,910	205,850
Total	226,736	1,136,940

Vessels.

Class.	Number.	Average draft.	Average tonnage.
		Feet.	
Steam	5	7	75
Sail	40	8	200
Barges	74	7½	300
Rafts .... feet B. M.	36	....	600,000
Total	155	....	....

Regular lines of transportation, June 30, 1902.—Norfolk and Southern Railroad Company, 1 steamer twice a day, Edenton to Plymouth, and 1 steamer 1 trip a day, Edenton to Hamilton, N. C.; Norfolk and Weldon Steamboat Company, 3 steamers, making triweekly trips between Norfolk and Weldon.

L 13.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

Wreck of barge Kingston.—The wreck of this craft was in Turners Cut, N. C., just below the bridge which crosses it about 1¼ miles below South Mills, N. C.

Proposals for its removal were solicited by public notice. Those received ranged from $155 to $901. The lowest proposition (that of C. Walker & Co.) was accepted, and this firm removed the wrecked barge between August 10 and 13, 1901. There were no expenses connected with the work of removal other than the amount paid the firm performing the work.

Wrecks of barges East New Market and Centennial.—These wrecks were in the Southern Branch of the Elizabeth River, Virginia, the former 125 feet southwest from Frey's wharf, Berkley, in from 5 to 10 feet of water at low tide, and the latter about 1,600 feet below the bridge of the Belt Line Railway, in 11 feet of water at low tide.

Proposals were invited by public notice, with the result that W. H. French, of Berkley, Va., was the lowest bidder for both wrecks at $190 each. His proposal was accepted, and work commenced on the removal of the *East New Market*, March 3, 1902. The vessel floated on the 8th of the same month, and was placed ashore out of the way of navigation. Immediately after disposing of the *East New Market* the work on the removal of the *Centennial* was begun, and the latter was floated March 27, 1902, and was taken possession of by the contractor and repaired.

The total cost of removing both wrecks was $535.

L 14.

ESTABLISHMENT OF HARBOR LINES IN PASQUOTANK RIVER AT ELIZABETH CITY, NORTH CAROLINA.

THE CHAMBER OF COMMERCE,
Elizabeth City, N. C., December 13, 1901.

DEAR SIR: The undersigned, a committee appointed by the Chamber of Commerce of this city, hereby make application for the establishment of a "*port-warden*" line for Elizabeth City, and request that you send an engineer at an early date as possible to survey and mark out the same. We have the honor to remain, yours, most respectfully,

EDMUND ALEXANDER,
Chairman.
W. W. MANN,
L. L. WINDER,
Committee.

HON. ELIHU ROOT,
Secretary of War.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
December 19, 1901.

Respectfully referred to Maj. James B. Quinn, Corps of Engineers, for report, attention being invited to the provisions of section 11 of the river and harbor act of March 3, 1899.

To be returned.

By command of Brig. Gen. Gillespie:

A. MACKENZIE,
Colonel, Corps of Engineers.

[Fifth indorsement.]

ENGINEER OFFICE, U. S. ARMY,
Norfolk, Va., May 3, 1902.

Respectfully returned to the Chief of Engineers, United States Army.

A tracing[a] indicating the harbor lines considered essential for the harbor at Elizabeth City, N. C., is forwarded in a separate package on this date. The harbor lines delineated thereon were determined after conferring with the within-named committee, and other interested citizens of Elizabeth City, and are recommended for adoption, since all the interests affected, so far as I am able to learn, will be conserved by the selected lines.

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[a] Not printed.

JAMES B. QUINN,
Major, Corps of Engineers.

[Sixth indorsement.]

OFFICE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
May 10, 1902.

Respectfully returned to the Secretary of War.

A committee of the Chamber of Commerce of Elizabeth City, N. C., make application for the establishment of harbor lines on the Pasquotank River at that place.

Inviting attention to the report of the local engineer officer in fifth indorsement hereon, I recommend that the lines selected be approved. These lines are delineated and described on the accompanying chart, which has been prepared for the signature of the Secretary.

G. L. GILLESPIE,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Seventh indorsement.]

WAR DEPARTMENT, *May 13, 1902.*

Approved as recommended by the Chief of Engineers.

E. ROOT,
Secretary of War.

APPENDIX M.

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN NORTH CAROLINA.

REPORT OF CAPT. E. W. VAN C. LUCAS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. **Ocracoke Inlet**, North Carolina.
2. **Fishing Creek**, North Carolina.
3. **Pamlico and Tar rivers**, North Carolina.
4. **Contentnia Creek**, North Carolina.
5. **Neuse River**, North Carolina.
6. **Trent River**, North Carolina.
7. **Inland Waterway**, between Newbern and Beaufort, North Carolina.
8. **Harbor at Beaufort**, North Carolina.
9. **Inland Waterway**, between Beaufort Harbor and New River, North Carolina.
10. New River, North Carolina.
11. Northeast (Cape Fear) River, North Carolina.
12. Black River, North Carolina.
13. Cape Fear River, North Carolina, above Wilmington.
14. Cape Fear River, North Carolina, at and below Wilmington.
15. Town Creek, North Carolina.

United States Engineer Office,
Wilmington, N. C., July 18, 1902.

General: I have the honor to submit herewith * * * my annual report for the year 1902, for river and harbor works under my charge * * * .

Very respectfully,

E. W. Van C. Lucas,
Captain, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

M 1.

IMPROVEMENT OF OCRACOKE INLET, NORTH CAROLINA.

No work of improvement has been done during the year, expenditures having been for maintenance and care of plant.

It is proposed to reserve the available balance for examinations to be made from time to time, when necessary, in order to keep a complete record of natural changes for use whenever its improvement is resumed.

No additional appropriation is recommended.

Money statement.

July 1, 1901, balance unexpended	$9,035.87
June 30, 1902, amount expended during fiscal year	562.34
July 1, 1902, balance unexpended	8,473.53

APPROPRIATED.

March 20, 1826, to March 3, 1837	$133,750.00
September 19, 1890	90,000.00
July 13, 1892	15,000.00
	238,750.00
Less amount carried to surplus fund	17.60
	238.732.40

M 2.

IMPROVEMENT OF FISHING CREEK, NORTH CAROLINA.

The small expenditure during the year was for the collection of commercial statistics, and no work was done for lack of funds.

The proposed application of the available balance is to maintain the natural channel as far up as Beach Swamp, and additional appropriations of $2,000 annually are recommended for this purpose.

Money statement.

July 1, 1901, balance unexpended	$37.84
Amount appropriated by river and harbor act approved June 13, 1902	2,000.00
	2,037.84
June 30, 1902, amount expended during fiscal year	3.34
July 1, 1902, balance unexpended	2,034.50
July 1, 1902, outstanding liabilities	28.79
July 1, 1902, balance available	2,005.71
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement in addition to the balance unexpended July 1, 1902 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	2,000.00

APPROPRIATED.

September 19, 1890	$10,000
July 13, 1892	5,000
March 3, 1899	7,750
June 13, 1902	2,000
Total	24,750

COMMERCIAL STATISTICS FOR YEAR ENDING DECEMBER 31, 1901.

Class of goods.	Tons.	Class of goods.	Tons.
Cotton seed	300	Fertilizer	125
Cotton-seed meal	100	General merchandise	5
Cotton-seed hulls	15	Peanuts	50
Wood	100		
Timber	2,000	Total	2,695

Number of passengers, none. Decrease since last year, 1,925 tons.

Statement of vessels navigating Fishing Creek, North Carolina, during the calendar year ending December 31, 1901.

Class of vessel.	Number.	Aggregate net tonnage.	Draft.
			Ft. in.
Steamer[a]	1	46	1 8

[a] Navigated the lower 8 miles of this stream a few times.

M 3.

IMPROVEMENT OF PAMLICO AND TAR RIVERS, NORTH CAROLINA.

[One river called the Pamlico below and the Tar above Washington, N. C.]

No work was done during the year for lack of funds, the small expenditure being for maintenance and care of plant.

* * * * * * *

Additional appropriations of $6,000 annually are recommended for the purpose of maintenance.

Money statement.

July 1, 1901, balance unexpended	$130.79
Amount appropriated by river and harbor act approved June 13, 1902	35,500.00
	35,630.79
June 30, 1902, amount expended during fiscal year	45.75
July 1, 1902, balance unexpended	35,585.04
July 1, 1902, outstanding liabilities	29.05
July 1, 1902, balance available	35,555.99
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	6,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

APPROPRIATED.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
July 4, 1836, to July 7, 1838	$10,000	$10,000	August 5, 1886	$5,000	$58,000
			August 11, 1888	10,000	68,000
August 14, 1876	15,000	15,000	September 19, 1890	10,000	78,000
May 3, 1879	6,000	21,000	July 13, 1892	10,000	88,000
June 14, 1880	9,000	30,000	August 18, 1894	10,000	98,000
March 3, 1881	8,000	38,000	June 3, 1896	5,000	103,000
August 2, 1882	10,000	48,000	March 3, 1899	15,000	118,000
July 5, 1884	5,000	53,000	June 13, 1902	35,500	153,500

COMMERCIAL STATISTICS FOR YEAR ENDING DECEMBER 31, 1901.

Class of goods.	Tons.	Class of goods.	Tons.
Cotton	10,328	Shingles	425.2
Cotton seed	9,375	Fertilizers	11,870
Cotton-seed oil	1,054	Machinery	244
Cotton-seed meal	3,605	General merchandise	76,108
Tobacco, leaf	21	Coal and minerals	3,904
Grains	10,642.2	Tar	30.6
Hay	3,157.5	Peanuts	201
Potatoes	20,528.2	Cotton-seed hulls	400
Vegetables	1,072	Rafting gear	42.5
Cattle	166.3	Railroad iron	922
Horses	189	Lime	4,000
Hogs	44.5	Shells	5,000
Poultry	54.2	Empty barrels	3,976
Eggs	388.2	Cabbage crates	568
Fish	72.5	Pea baskets	2
Oysters	16,262	Gum timber	1,000
Clams	150	Truck	3,000
Rosin	5	Hides	14.5
Wood	8,160	Junk	40
Timber	478,707.7		
Rice, rough	156.4	Total	935,311.5
Lumber	259,425		

Increase over last year, 321,416.5 tons.

Number of passengers, 13,293.

Transportation lines established during the year, 1 steamboat line.

Three hundred and three thousand eight hundred and eleven tons of the above total was exported.

Statement of vessels navigating Pamlico and Tar rivers, North Carolina, during calendar year ending December 31, 1901.

Class of vessel.	Number.	Aggregate net tonnage.	Draft.
			Feet.
Steamers	44	2,869	2.5 to 9
Sloops and schooners	42	1,097	2 to 8
Barges	40	11,000	5 to 9

In addition to the above there are numerous small sailing craft whose tonnage and number have not been taken into consideration.

M 4.

IMPROVEMENT OF CONTENTNIA CREEK, NORTH CAROLINA.

No work of improvement was done during the year for lack of funds, the expenditures having been for maintenance and care of plant.

The available balance is too small to warrant any work, although the stream is reported as in need of clearing,

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$212.20
June 30, 1902, amount expended during fiscal year	174.03
July 1, 1902, balance unexpended	38.17
July 1, 1902, outstanding liabilities	.60
July 1, 1902, balance available	37.57
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	2,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

APPROPRIATIONS.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
March 3, 1881	$10,000	$10,000	September 19, 1890	$7,000	$52,000
August 2, 1882	10,000	20,000	July 13, 1892	7,000	59,000
July 5, 1884	5,000	25,000	August 18, 1894	10,000	69,000
August 5, 1886	15,000	40,000	March 3, 1899	2,000	71,000
August 11, 1888	5,000	45,000			

M 5.

IMPROVEMENT OF NEUSE RIVER, NORTH CAROLINA.

No work of improvement was done during the year for lack of funds, the expenditures being for maintenance and care of plant.

* * * * * * *

Additional appropriations are recommended of $14,000 to complete the dredging project at and below Newbern, and of $6,000 annually to maintain the present channel above Newbern.

Money statement.

July 1, 1901, balance unexpended		$122.26
Amount appropriated by river and harbor act approved June 13, 1902		[a]13,500.00
		13,622.26
June 30, 1902, amount expended during fiscal year		87.10
July 1, 1902, balance unexpended		13,535.16
July 1, 1902, outstanding liabilities		15.69
July 1, 1902, balance available		13,519.47
Amount (estimated) required for completion of existing project		91,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$14,000.00	
For maintenance of improvement	6,000.00	
		20,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

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[a] Allotted from $20,000 joint appropriation.

APPROPRIATIONS.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
June 18, 1878	$40,000	$40,000	August 11, 1888	$15,000	$247,500
March 3, 1879	45,000	85,000	September 30, 1890	20,000	267,500
June 14, 1880	45,000	130,000	July 13, 1892	15,000	282,500
March 3, 1881	30,000	160,000	August 18, 1894	7,000	289,500
August 2, 1882	30,000	190,000	June 3, 1896	7,000	296,500
July 5, 1884	20,000	210,000	March 3, 1899	10,000	306,500
August 5, 1886	22,500	232,500	June 13, 1902	[a] 13,500	320,000

[a] Allotted from appropriation of $20,000 for Neuse and Trent rivers, North Carolina.

COMMERCIAL STATISTICS FOR YEAR ENDING DECEMBER 31, 1901.

Class of goods.	Tons.	Class of goods.	Tons.
Cotton	6,959.5	Oysters	2,464.3
Cotton seed	1,950	Clams	2,169
Cotton-seed oil	662.5	Rosin	1,242
Cotton-seed meal	1,020	Turpentine, spirits	163
Tobacco, leaf	262	Wood	846
Rice, rough	22.2	Timber	104,307.8
Grains	10,489.5	Lumber	131,722.2
Hay	2,806	Shingles	1,917.5
Potatoes	5,697.5	Fertilizers	19,863
Vegetables	3,301.5	Machinery	3,020
Cattle	1	General merchandise	14,825.9
Horses	52	Coal and minerals	3,884
Hogs	.5	Tar	285.7
Poultry	32.5	Cotton-seed hulls	175
Eggs	67.7		
Fish	740	Total	320,949.8

Increase since last year, 86,837.8 tons.

Number of passengers, 12,790.

One hundred and sixty thousand two hundred and twenty tons of total commerce were exported.

Statement of vessels navigating Neuse River, North Carolina, during the calendar year ending December 31, 1901.

Class of vessel.	Number.	Aggregate net tonnage.	Draft.
			Feet.
Steamers	34	2,008	2 to 7.5
Barges	20	5,580	6 to 8
Schooners and sloops	179	6,512	2 to 8

M 6.

IMPROVEMENT OF TRENT RIVER, NORTH CAROLINA.

No work of improvement was done during the year for lack of funds, the expenditures being for maintenance and care of plant.

With the available balance it is proposed to maintain the channel between Newbern and Trenton and to do as much as possible of the dredging at Newbern, in accordance with the report on examination and survey published in the annual report for 1901, page 1545, and also in House Ex. Doc. No. 121, Fifty-sixth Congress, second session.

Additional appropriations are recommended of $19,000 for completing the dredging project, and of $2,500 annually for maintenance of channel to Trenton.

Money statement.

July 1, 1901, balance unexpended		$384.32
Amount appropriated by river and harbor act approved June 13, 1902		[a]6,500.00
		6,884.32
June 30, 1902, amount expended during fiscal year		315.99
July 1, 1902, balance unexpended		6,568.33
July 1, 1902, outstanding liabilities		41.79
July 1, 1902, balance available		6,526.54
Amount (estimated) required for completion of existing project		19,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$19,000.00	
For maintenance of improvement	2,500.00	
		21,500.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Appropriated.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
March 3, 1879	$7,000	$7,000	September 19, 1890	$5,000	$55,500
June 14, 1880	10,000	17,000	July 13, 1892	5,000	60,500
March 3, 1881	5,000	22,000	August 18, 1894	4,000	64,500
August 2, 1882	10,000	32,000	June 3, 1896	2,000	66,500
July 5, 1884	10,000	42,000	March 3, 1899	2,500	69,000
August 5, 1886	3,500	45,500	June 13, 1902	[a]6,500	75,500
August 11, 1888	5,000	50,500			

[a] Allotted from $20,000 appropriated for Neuse and Trent rivers, North Carolina.

COMMERCIAL STATISTICS FOR YEAR ENDING DECEMBER 31, 1901.

Class of goods.	Tons.	Class of goods.	Tons.
Cotton	5,922	Clams	186.9
Cotton seed	3,160	Rosin	1,242
Cotton-seed oil	.3	Turpentine, spirits	160
Cotton-seed meal	2,256	Wood	1,390
Rice, rough	600	Timber	66,920.3
Grains	5,198.6	Lumber	31,878.5
Hay	2,390	Shingles	3,093.5
Potatoes	5,654.2	Fertilizers	10,700
Vegetables	2,250.8	Machinery	3,120
Cattle	320	General merchandise	18,700
Horses	64	Coal and minerals	420
Hogs	13.5	Tar	103
Poultry	61	Peanuts	10
Eggs	92.3	Kerosene oil	230
Fish	588		
Tobacco, leaf	253	Total	166,987.5
Oysters	9.6		

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[a] Allotted from $20,000, joint appropriation.

Of the above total, 52,482 tons was foreign and coastwise, and 114,505.5 tons internal.

Gain over last year, 36,825.5 tons; foreign and coastwise, 12,617 tons; internal, 24,208.5 tons.

Number of passengers, 920.

Statement of vessels navigating Trent River, North Carolina, during the calendar year ending December 31, 1901.

Class of vessel.	Number.	Aggregate net tonnage.	Draft.
			Feet.
Steamers	21	1,540	2 to 7.5
Schooners, sloops, etc	187	5,840	2 to 7.5
Barges	10	2,790	6 to 8

M 7.

IMPROVEMENT OF INLAND WATERWAY BETWEEN NEWBERN AND BEAUFORT, NORTH CAROLINA (VIA NEUSE RIVER, CLUBFOOT CREEK, CLUBFOOT AND HARLOWE PRIVATE CANAL, HARLOWE CREEK, AND NEWPORT RIVER).

No work of improvement was done during the year, the expenditures being for outstanding liabilities incurred in making survey during June, 1901. The work on this waterway has been suspended for several years pending the cession or sale to the Government of the private canal included therein. The survey of June, 1901, indicated a number of shoals and the necessity for considerable work in order to obtain project depth and width, which work would be useless unless the canal company made a corresponding increase in the canal itself.

No present application of available balance is contemplated and no additional appropriation is at present recommended.

No commercial statistics for 1901 were obtainable.

Money statement.

July 1, 1901, balance unexpended	$6,455.40
June 30, 1902, amount expended during fiscal year	151.71
July 1, 1902, balance unexpended	6,303.69
Amount (estimated) required for completion of existing project	57,000.00

APPROPRIATED.

Date.	Amount.	Aggregate.
August 2, 1882	$10,000	$10,000
August 5, 1886	10,000	20,000
August 11, 1888	15,000	35,000

M 8.

IMPROVEMENT OF HARBOR AT BEAUFORT, NORTH CAROLINA.

No work of improvement was done for lack of funds, the expenditures being for maintenance and care of plant.

* * * * * * *

An additional appropriation of $3,000 annually is recommended for maintenance of this improvement.

Money statement.

July 1, 1901, balance unexpended	$99.23
Amount appropriated by river and harbor act approved June 13, 1902	3,000.00
	3,099.23
June 30, 1902, amount expended during fiscal year	73.97
July 1, 1902, balance unexpended	3,025.26
July 1, 1902, outstanding liabilities	3.79
July 1, 1902, balance available	3,021.47
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	3,000.00

APPROPRIATED.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
July 4, 1836	$5,000	$5,000	August 11, 1888	$35,000	$125,000
March 3, 1880	30,000	30,000	September 19, 1890	15,000	140,000
August 2, 1882	25,000	55,000	July 13, 1892	10,000	150,000
July 5, 1884	20,000	75,000	June 3, 1896	5,000	155,000
August 5, 1886	15,000	90,000	June 13, 1902	3,000	158,000

COMMERCIAL STATISTICS FOR YEAR ENDING DECEMBER 31, 1901.

Class of goods.	Tons.	Class of goods.	Tons.
Cotton	163.8	Wood	6,085
Cotton seed	98	Timber	2,875
Cotton-seed meal	37.5	Lumber	9,243
Rice, rough	15.5	Shingles	200.2
Grains	150.1	Fertilizers	1,275
Hay	160	General merchandise	527.8
Potatoes	315.3	Coal and minerals	400
Vegetables	1.5	Tar	.7
Cattle	125.5	Terrapins	.3
Horses	7.5	Crabs	56
Hogs	71	Game	1.5
Poultry	4.5	Fish oil	1,609
Eggs	19.8	Fish scrap	2,196.2
Fish	17,243.7		
Oysters	24,120	Total	72,183.4
Clams	5,180		

Increase since 1899, 32,827.4 tons.

Number of passengers, 13,200.

Transportation lines established during the year, Beaufort to Ocracoke, N. C., carrying United States mail.

Statement of vessels navigating harbor at Beaufort, N. C., during the calendar year ending December 31, 1901.

Class of vessel.	Number.	Aggregate net tonnage.	Draft.
			Feet.
Steamers	9	369	2.5 to 7
Schooners and sloops	199	1,859	2 to 9
Naphtha launches[a]	3	[b]25	....
Auxiliary yachts	5	[b]125	3 to 5

[a] Not registered in Blue Book of 1899.

[b] Estimated.

In addition to the above, numerous small steamers enter the harbor annually in passing up and down the coast from the North to Florida.

M 9.

IMPROVEMENT OF INLAND WATERWAY BETWEEN BEAUFORT HARBOR AND NEW RIVER, NORTH CAROLINA.

No work of improvement was done during the year, the available balance being too small for advantageous application. The expenditures covered the cost of collecting commercial statistics.

* * * * * * *

After the completion of this project, additional appropriations about $2,000 annually will be needed to maintain the channel

Money statement.

July 1, 1901, balance unexpended	$955.6
Amount appropriated by river and harbor act approved June 13, 1902	9,500.0
	10,455.66
June 30, 1902, amount expended during fiscal year	6.02
July 1, 1902, balance unexpended	10,449.64

APPROPRIATED.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
August 5, 1886	$10,000	$10,000	August 18, 1894	$2,500	$42,500
August 11, 1888	5,000	15,000	June 3, 1896	1,000	43,500
September 19, 1890	15,000	30,000	June 13, 1902	9,500	53,000
July 13, 1892	10,000	40,000			

COMMERCIAL STATISTICS FOR YEAR ENDING DECEMBER 31, 1901.

Class of goods.	Tons.	Class of goods.	Tons.
Cotton	77.5	Turpentine, crude	12.1
Cotton seed	180	Turpentine, spirits	80.6
Grains	100.6	Timber	12,500
Hay	93	Lumber	10,000
Potatoes	4.1	Fertilizers	170
Eggs	1.3	General merchandise	5,985
Fish	1,515	Peanuts	2.1
Oysters	1,200	Pitch	53
Rosin	273		
Clams	1,720	Total	33,917.2

Increase since 1899, 12,669.2 tons.

Number of passengers, none.

Statement of vessels navigating waterway between Beaufort Harbor and New River, North Carolina, during the calendar year ending December 31, 1901.

Class of vessel.	Number.	Aggregate net tonnage.	Draft.
			Feet.
Steamers	2	81	4
Schooners and sloops	31	310	2 to 4

In addition to the above, there are probably 150 light-draft sharpies that navigate this waterway occasionally.

M 10.

IMPROVEMENT OF NEW RIVER, NORTH CAROLINA.

No work of improvement was done during the year and no expenditures were made.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$3,371.26
July 1, 1902, balance unexpended	3,371.26

APPROPRIATED.

Date	Amount.	Aggregate.	Date.	Amount.	Aggregate.
July 4, 1836, to July 7, 1838		$50,000	August 5, 1886	$10,000	$20,000
			August 11, 1888	3,000	23,000
August 2, 1882	$5,000	5,000	September 19, 1890	5,000	28,000
July 4, 1884	5,000	10,000	July 13, 1892	5,000	33,000

COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1901.

Class of goods.	Tons.	Class of goods.	Tons.
Cotton	52.5	Oysters	400
Cotton seed	120	Clams	100
Cotton-seed meal	10	Rosin	857.1
Tobacco, leaf	.25	Turpentine, spirits	200
Hay	50	Fertilizers	150
Potatoes	100	General merchandise	1,000
Poultry	2	Peanuts	14.3
Eggs	30		
Fish	500	Total	3,556.45

Increase since last year, 310.45 tons.
Number of passengers, none.

Statement of vessels navigating New River, North Carolina, during calendar year ending December 31, 1901.

Class of vessel.	Number.	Aggregate net tonnage.	Draft.
			Feet.
Steamers	2	39	2.5
Schooners	2	34	4

M II.

IMPROVEMENT OF NORTH EAST (CAPE FEAR) RIVER, NORTH CAROLINA.

No work of improvement was done during the year for lack of funds and no expenditures were made.

* * * * * * *

Additional appropriations of $3,000 annually are recommended for the maintenance of the natural channel.

Money statement.

July 1, 1901, balance unexpended	$4.68
Amount appropriated by river and harbor act approved June 13, 1902	[a]2,000.00
July 1, 1902, balance unexpended	2,004.68
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	3,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATED.

September 19, 1890, for North East (Cape Fear) River, North Carolina	$5,000.00
July 13, 1892, for North East (Cape Fear) River, North Carolina	5,000.00
August 18, 1894, for North East (Cape Fear) River, North Carolina	5,000.00
March 3, 1899, for North East River, North Carolina	2,000.00
June 13, 1902, for North East River, North Carolina	[a]2,000.00
Other receipts, March 4, 1897, sales to Cape Fear River	243.33
Total	19,243.33

COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1901.

Class of goods.	Tons.	Class of goods.	Tons.
Cotton	382	Turpentine:	
Cotton seed	803	Crude	229
Cotton-seed meal	82	Spirits	298
Cotton-seed oil	2	Tar	812
Rice, rough	11	Wood	8,041
Grains	185	Timber	26,206
Hay and rice straw	28	Lumber	1,222
Potatoes	60	Shingles and shingle blocks	1,250
Peanuts	15	Poles and piles	1,824
Fruit and vegetables	5	Cross-ties	108
Cattle	33	Brick	3,750
Hogs	30	Fertilizer	16,015
Eggs	9	General merchandise	4,000
Poultry	31	Lime	120
Fish	1		
Rosin	1,821	Total	66,873

Increase since last year, 10,125 tons.
Number of passengers, 215.

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[a] Allotted from joint appropriation of $10,000 for North East and Black rivers, North Carolina, and Cape Fear River, North Carolina, above Wilmington.

Statement of vessels navigating Northeast River, North Carolina, during calendar year ending December 31, 1901.

Class of vessels.	Number.	Aggregate net tonnage.	Draft.
			Feet.
Steamers	2	111	3 to 3.5
Steam tugs	9	167	2.5 to 7.5
Flats, about	45	3,375	1.5 to 4

M 12.

IMPROVEMENT OF BLACK RIVER, NORTH CAROLINA.

No work of improvement was done during the year for lack of funds, the expenditures being for maintenance and care of plant.

* * * * * * *

Additional appropriations of $3,000 annually are recommended for the maintenance of this stream.

Money statement.

July 1, 1901, balance unexpended	$309.27
Amount appropriated by river and harbor act approved June 13, 1902	[a] 2,000.00
	2,309.27
June 30, 1902, amount expended during fiscal year	20.00
July 1, 1902, balance unexpended	2,289.27
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	3,000.00

Appropriated.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
August 5, 1886	$3,000.00	$3,000.00	March 3, 1899	$2,000.00	$18,000.00
July 13, 1892	10,000.00	13,000.00	June 13, 1902	[a] 2,000.00	20,000.00
August 17, 1894	2,000.00	15,000.00	Other receipts: Sales, etc.		243.34
June 3, 1896	1,000.00	16,000.00			

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[a] Allotted from joint appropriation of $10,000 for North East and Black rivers, North Carolina, and Cape Fear River, North Carolina, above Wilmington.

COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1901.

Class of goods.	Tons.	Class of goods.	Tons.
Cotton	200	Tar	1,817
Cotton seed	70	Wood	7,500
Cotton-seed meal	22	Timber	26,840
Grains	55	Lumber	250
Hay	70	Shingles	1,875
Potatoes	31	Poles	75
Cattle	93	Cross-ties	60
Horses	6	General merchandise	15,000
Hogs	31	Machinery	10
Poultry	32	Rice, rough	10
Eggs	20	Peanuts	11
Fertilizer	840	Dog tongue	17
Rosin	5,245	Fish	2
Turpentine:		Fruit and vegetables	5
Crude	285		
Spirits	597	Total	61,069

Increase since last year, 2,982 tons.

Number of passengers, 704.

All the above passed over 12 miles of Cape Fear River, North Carolina, above Wilmington, but is not included in the report for that river.

Statement of vessels navigating Black River, North Carolina, during the calendar year ending December 31, 1901.

Class of vessels.	Number.	Aggregate net tonnage.	Draft.
			Feet.
Steamers	4	158	3 to 3.5
Steam tugs	4	44	3.5 to 4.5
Flats (about)	40	3,000	1.5 to 4.5

M 13.

IMPROVEMENT OF CAPE FEAR RIVER, NORTH CAROLINA, ABOVE WILMINGTON.

No work of improvement was done during the year for lack of funds, the expenditure being for maintenance and care of plant.

With the available balance it is proposed to maintain the natural channel up to Fayetteville, to do the preliminary work necessary for determining lock and dam sites under the canalization project for obtaining 8 feet depth to Fayetteville, and to purchase sites for locks and dams when locations are determined.

Additional appropriations are recommended of $8,000 annually for the maintenance of the present channel to Fayetteville, and of $400,000 for the construction of the first lock and dam. It is not believed advisable to begin the construction of a lock and dam until funds are available for its completion under one contract.

Money statement.

July 1, 1901, balance unexpended		$80.05
Amount appropriated by river and harbor act approved June 13, 1902		[a]56,000.00
		56,080.05
June 30, 1902, amount expended during fiscal year		33.35
July 1, 1902, balance unexpended		56,046.70
July 1, 1902, outstanding liabilities		21.36
July 1, 1902, balance available		56,025.34
Amount (estimated) required for completion of existing project		1,300,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$400,000.00	
For maintenance of improvement	8,000.00	
		408,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

APPROPRIATED.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
March 3, 1881	$30,000	$30,000	August 18, 1894	$14,000	$132,250.00
August 2, 1882	30,000	60,000	June 3, 1896	5,000	137,250.00
July 5, 1884	5,000	65,000	March 3, 1899	5,000	142,250.00
August 5, 1886	11,250	76,250	June 13, 1902[a]	56,000	198,250.00
August 11, 1888	12,000	88,250	Other receipts, sales to other appropriations during 1897		414.33
September 19, 1890	15,000	103,250			
July 13, 1892	15,000	118,250			

COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1901.

Class of goods.	Tons.	Class of goods.	Tons.
Cotton	732	Tar	3,176
Cotton seed	265	Wood	11,400
Cotton-seed meal	354	Timber	29,426
Cotton-seed oil	45	Lumber	300
Grains	89	Shingles	1,250
Rice	162	Fertilizer	29,827
Straw	200	Machinery	58
Hay	83	General merchandise	31,900
Potatoes	45	Manufactured cotton goods	571
Cattle	291	Brick	3,870
Horses	50	Peanuts	6
Hogs	57	Fish	18
Poultry	103	Fruits and vegetables	2
Eggs	75	Pitch	117
Rosin	3,656	Cross ties	1,029
Turpentine:		Poles and piles	3,995
Crude	424		
Spirits	536	Total	124,112

Number of passengers, 2,205.

Decrease since last year, 5,510 tons.

All of Black River commerce, 61,069 tons, passes over 12 miles of this river, but is not included in the above.

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[a] Six thousand dollars allotted from joint appropriation of $10,000 for North East and Black rivers, North Carolina, and Cape Fear River, North Carolina, above Wilmington.

Statement of vessels navigating Cape Fear River, North Carolina, above Wilmington, during the year ending December 31, 1901.

Class of vessels.	Number.	Aggregate net tonnage.	Draft.
			Feet.
Steamers	6	439	3 to 4
Steam tugs	6	128	3.5 to 7
Flats (about)	40	3,000	1.5 to .54

M 14.

IMPROVEMENT OF CAPE FEAR RIVER, NORTH CAROLINA, AT AND BELOW WILMINGTON.

No work of improvement was done during the year for lack of funds, operations having been restricted to maintenance work with the suction dredge *Cape Fear* in the bar and Snows Marsh channels, to repair work on the Swash Defense dam, to repair and maintenance of plant, and to survey and estimate work. The suction dredge *Cape Fear*, during July and August, removed from the ocean bar 15,624 cubic yards of sand, and from Snows Marsh channel 22,121 cubic yards. On August 12 this dredge was sent to Savannah for work on the channel leading to that city, and has since been operating under the Savannah and Charleston offices.

The repairs on the Swash Defense dam consisted of placing 1,109 tons of rock in the worst breach.

With the available balance it is proposed: (1) To connect the old Woodbury jetty with the beach at Baldhead to protect against further erosion; (2) to redredge the river channel where shoaling has occurred; (3) to repair the Swash Defense and New Inlet dams and Snows Marsh dike; (4) to remove the obstructions from the mouth of Brunswick River, and (5), if funds permit, to construct mooring dolphins at Wilmington. Should any balance remain, it will be applied to the work of continuing the improvement under the project of October 6, 1890, to obtain 20 feet depth and 270 feet width from Wilmington to the ocean, about 60 per cent of which has been done. But it is believed the available balance will hardly suffice to do the necessary work of restoration above outlined, and no further progress with the project is expected until further appropriations are made.

Additional appropriations are recommended of $250,000 for continuing the improvement, and of $50,000 for maintenance.

Money statement.

July 1, 1901, balance unexpended		$32,077.47
December 21, 1901, received amount for dredge Cape Fear		3,255.00
Amount appropriated by river and harbor act approved June 13, 1902		150,000.00
		185,332.47
June 30, 1902, amount expended during fiscal year		23,195.16
July 1, 1902, balance unexpended		162,137.31
July 1, 1902, outstanding liabilities		182.42
July 1, 1902, balance available		161,954.89
Amount (estimated) required for completion of existing project		885,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$250,000.00	
For maintenance of improvement	50,000.00	
		300,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

Appropriated.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
March 2, 1829, to July 22, 1854		[a]$363,228.92	August 2, 1882	$225,000	$1,502,500.00
July 11, 1870	$100,000	100,000.00	July 5, 1884	200,000	1,702,500.00
March 3, 1871	75,000	175,000.00	August 5, 1886	157,500	1,860,000.00
June 10, 1872	100,000	275,000.00	August 11, 1888	245,000	2,105,000.00
March 3, 1873	100,000	375,000.00	September 19, 1890	170,000	2,275,000.00
June 23, 1874	150,000	525,000.00	July 13, 1892	200,000	2,475,000.00
March 3, 1875	150,000	675,000.00	August 18, 1894	200,000	2,675,000.00
August 14, 1876	132,500	807,500.00	June 3, 1896	195,000	2,870,000.00
June 18, 1878	160,000	967,500.00	March 3, 1899	150,000	3,020,000.00
March 3, 1879	100,000	1,067,500.00	June 13, 1902	150,000	3,170,000.00
June 14, 1880	70,000	1,137,500.00	Other receipts: Sales and rents to other appropriations.		15,591.53
March 3, 1881	140,000	1,277,500.00			

[a] Balance of $3,728.07 turned over to surplus fund.

COMMERCIAL STATISTICS FOR YEAR ENDING DECEMBER 31, 1901.

Exports, foreign and coastwise.

[Furnished by Col. J. L. Cantwell, secretary of the Wilmington Produce Exchange.]

	Tons.
Cotton	61,864
Manufactured cotton and yarn goods	1,144
Lumber	90,391
Shingles	4,235
Rosin	18,092
Tar	9,994
Turpentine:	
Spirits	4,159
Crude	3,017
Pitch	560
Peanuts	1,997
Paper stock	8
Miscellaneous	65,000
Total	260,461

Exports, internal.

[Furnished by steamboat, flat, and raft men.]

	Tons.
Miscellaneous	100,448

Total of exports (foreign, coastwise, and internal), 360,909 tons.

Imports, foreign and coastwise.

[Furnished by importers and manufacturers.]

	Tons.
Fertilizers and fertilizer material	66,572
Coal	14,038
Salt	4,371
Oil	15,124
Cement	3,376
Grain (corn and rice)	1,500
Miscellaneous (naval stores, cotton, and general merchandise)	100,000
Total	204,981

Imports, internal.

[Furnished by steamboat, flat, and raft men.]

	Tons.
Cotton	1,334
Manufactured cotton goods	571
Tar	6,057

	Tons.
Turpentine:	
Spirits	1,616
Crude	1,088
Rosin	11,586
Lumber and timber	93,025
Shingles	4,397
Wood	30,941
Brick	7,620
Miscellaneous	3,234
Total	161,469

Total of imports (foreign, coastwise, and internal), 366,450 tons.

SUMMARY.

	Tons.
Exports:	
Foreign and coastwise	260,461
Internal	100,448
Imports:	
Foreign and coastwise	204,981
Internal	161,469
Total commerce	727,359

Increase since last year, 28,003 tons.

Foreign commerce for the year 1901.

[Furnished by the collector of customs of the port of Wilmington, N. C.]

Class of goods.		Quantity.	Value.
EXPORTS.			
Cotton	bales..	222,926	$9,371,000
Rosin	barrels..	108,239	141,273
Tar	do....	9,997	17,081
Pitch	do....	1,276	1,936
Spirits turpentine	gallons..	37,850	14,201
Lumber	M feet..	8,824	125,167
Shingles	M..	1,198	6,566
Miscellaneous	tons..	....	9,840
Total		....	9,687,064
IMPORTS.			
Kainit	tons..	20,232	$96,125
Salt	do....	1,370	2,332
Potash (M. and S. of)	do....	2,899	108,317
Pyrites	do....	14,105	38,217
Molasses	gallons..	3,252	477
Miscellaneous	tons..	....	43,994
Total		....	284,462

Cotton steamers loaded at the port of Wilmington, N. C., during the calendar year ending December 31, 1901.

[Furnished by Messrs. Alex. Sprunt & Son and by Mr. J. B. Sloan.]

Name.	Registered tonnage.	Draft, loaded.	Bales.	Name.	Registered tonnage.	Draft, loaded.	Bales.
		Feet.				*Feet.*	
Chatfield	1,904	18.5	9,931	Candleshoe	2,466	19	14,147
Buckminster	1,297	17.5	6,881	Hurwurth	1,521	17	7,747
Dora	1,105	16.5	5,744	Bolana	1,898	18	9,433
Oaklands	1,252	16.5	6,384	Wragby	2,371	18	12,642
Torgorin	1,065	16.5	5,872	Wandby	2,580	19	14,827
Roxby	1,964	19	10,186	Jessmore	1,548	18	7,570
Crathorne	1,695	19	9,010	Tolosa	2,099	17.5	11,184
Naparima	1,043	16.5	5,332	Riftswood	1,166	16	5,903
Haxby	2,252	19.8	11,909	Ethelaida	1,705	....	8,926
Skidby	2,421	19.5	12,887	Tripoli	1,687	....	9,351
Tenby	2,558	19	14,382	Roda	1,588	....	6,303
Slingsby	2,093	19.5	11,183				
Mountby	2,114	16.5	11,105	Total	43,392	....	228,839

Statement of foreign and coastwise vessels of 100 tons and over at the port of Wilmington, N. C., for the calendar year ending December 31, 1901.

[Furnished by Capt. Edgar Williams, harbor master.]

Class of vessel.	American.		Foreign.		Total.	
	Number.	Tonnage.	Number.	Tonnage.	Number.	Tonnage.
Steamers	113	145,150	40	67,026	153	212,176
Barks	2	1,050	21	11,213	23	12,263
Brigs	3	865			3	865
Barges	13	15,910			13	15,910
Schooners	92	31,958	9	1,816	101	33,774
Total	223	194,933	70	80,055	293	274,988

The above does not include vessels which took cargoes to Southport; vessels coming to Southport in distress, for supplies or for a harbor, the total estimated tonnage of which is 15,000; or vessels and barges taking cargoes to Fort Caswell, the total estimated tonnage of which is 25,000.

Vessels owned by the United States Government are not included. No record is made of steamboats plying on the rivers above Wilmington, or of small vessels and steam tugs of less than 100 tons.

Statement of vessels plying on the Cape Fear River, North Carolina, at and below Wilmington, during the calendar year ending December 31, 1901.

[This statement is in addition to that furnished by Capt. Edgar Williams.]

Class of vessel.	Number.	Aggregate net tonnage.	Draft.
			Feet.
Steamers	18	6,020	2 to 17
Steam tugs	11	259	2 to 10

M 15.

IMPROVEMENT OF TOWN CREEK, BRUNSWICK COUNTY, NORTH CAROLINA.

No work of improvement was done during the year, the project of 1899 having been completed and the funds nearly exhausted.

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Money statement.

July 1, 1901, balance unexpended	$97.55
July 1, 1902, balance unexpended	97.55
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	2,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

ABSTRACT OF APPROPRIATIONS.

March 3, 1881	$1,000.00
March 3, 1899	8,500.00
Total	9,500.00

COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1901.

Class of goods.	Tons.	Class of goods.	Tons.
Cotton	20	Timber	1,400
Cotton seed	15	Lumber	290
Cotton-seed meal	30	Poles and piles	300
Rice, rough	144	Shingles	22
Hay	10	Machinery	48
Rice straw	300	Fertilizer	135
Potatoes	105	General merchandise	1,150
Cattle	1	Fish	1
Hogs	12	Watermelons	25
Poultry	8	Peanuts	105
Eggs	3	Grains	163
Rosin	864	Tar	252
Turpentine:		Fruits and vegetables	5
Crude	150	Brick	120
Spirits	188		
Wood	4,000	Total	9,863

Increase since last year, 717 tons.
Number of passengers, 175.

Statement of vessels navigating Town Creek, North Carolina, during the calendar year ending December 31, 1901.

Class of vessels.	Number.	Aggregate net tonnage.	Draft.
			Feet.
Steamers	1	31	4.3
Steam tugs	4	51	3.8 to 4.3
Sharpies	1	11	4
Flats	[a] 10	250	3

[a] Estimated.

APPENDIX N.

IMPROVEMENT OF WACCAMAW RIVER, NORTH CAROLINA AND SOUTH CAROLINA, AND OF CERTAIN RIVERS AND HARBORS IN SOUTH CAROLINA.

REPORT OF CAPT. J. C. SANFORD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORK.

IMPROVEMENTS.

1. **Waccamaw River, North Carolina and South Carolina.**
2. **Little Pedee River, South Carolina.**
3. **Great Pedee River, South Carolina.**
4. **Winyah Bay, South Carolina.**
5. **Santee River, South Carolina.**
6. **Wateree River, South Carolina.**
7. **Congaree River, South Carolina.**
8. **Congaree River, South Carolina, from Gervais Street Bridge, Columbia, to Granby.**
9. **Inland waterways between Charleston Harbor, South Carolina, and opposite McClellanville.**
10. **Harbor at Charleston, South Carolina.**
11. **Wappoo Cut, South Carolina.**
12. **Inland waterway between Charleston and Beaufort, South Carolina.**
13. **Beaufort River, South Carolina.**
14. **Removing sunken vessels or craft obstructing or endangering navigation.**
15. **Construction of seagoing hydraulic dredges.**

UNITED STATES ENGINEER OFFICE,
Charleston, S. C., July 19, 1902.

GENERAL: I have the honor to transmit herewith my annual reports for the fiscal year ending June 30, 1902, for the works of improvement of rivers and harbors in this district.

Very respectfully, your obedient servant,

J. C. SANFORD,
Captain of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

N I.

IMPROVEMENT OF WACCAMAW RIVER, NORTH CAROLINA AND SOUTH CAROLINA.

No work was done during the year except care and maintenance of plant. * * *

The river and harbor act approved June 13, 1902, contains the following item:

Improving Waccamaw River, North Carolina and South Carolina, and Little Pedee River, South Carolina: Continuing improvement and for maintenance, ten thousand five hundred dollars.

It is proposed to apply the available balance and allotment to be made from above combined appropriation, to making a survey of the river, to determine its present condition and the amount now required to complete the project; also, so far as funds provided will permit, to deepen and widen the channel by dredging to the dimensions contemplated by the project, and to keep the river clear of snags and other similar obstructions.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$312.36
June 30, 1902, amount expended during fiscal year	36.86
July 1, 1902, balance unexpended	275.50

For this improvement the following appropriations have been made:

By act of Congress—		By act of Congress—	
Approved June 14, 1880	$15,000	Approved July 13, 1892	$10,000
Approved March 3, 1881	10,000	Of August 18, 1894	6,000
Passed August 2, 1882	4,400	Of June 3, 1896	6,000
Approved July 5, 1884	6,000	Approved March 3, 1899	3,000
Approved August 5, 1886	15,000		
Of August 11, 1888	15,000	Total	102,900
Approved September 19, 1890	12,500		

Total expenditures, including June 30, 1902, $102,624.50.

COMMERCIAL STATISTICS, 1901.

* * * * * * *

Articles.	Tons.	Value.
OUTWARD FREIGHTS.		
Naval stores	22,000	$633,000
Cotton	555	88,800
Timber, lumber, and cord wood	243,250	1,183,900
Rice and rice flour	5,000	400,000
Fish, game, and vegetables	700	30,000
Miscellaneous	150	50,000
Total	271,655	2,385,700
INWARD FREIGHTS.		
Miscellaneous	25,000	1,300,000
Fertilizers	6,000	150,000
Grand total	302,655	3,835,700

List of vessels plying on Waccamaw River, North Carolina and South Carolina, during the calendar year 1901.

Name.	Character.	Length.	Breadth.	Depth.	Draft loaded.	Gross Tonnage.
		Feet.	*Feet.*	*Feet.*	*Feet.*	
Bayard Hopkins	Schooner	118	30	9	10.6	269
E. A. Danenhower	do	116.6	30.2	8.7		228
Wm. Linthicum	do	112	27.6	8	9.6	156
Robert McClintock	do	96	26.7	7.4	8	154
Edward L. Martin	do	87.2	23.6	6.8		84
Chas. Linthicum	do	104	26.4	8.2	8.6	131
Venus	do	108	29.4	9.1	11.6	204
Wm. P. Congdon	Screw tug	75.2	18	7		68
S. S. Brewster	do	77.5	18.5	7		50
Martha Helen	do	83	16.7	7.4		75
Bon Accord	do	67.3	14.4	5		42
Henry Lloyd	do	40.5	12.2	4.8		13
Fearless	do	58	11	4		18
Emma A. Twiggs	do	53	13.2	4.5		16
Pender	do	52.7	14.9	3.4		28
Bertie	do	49.5	9.8	3.5		16
Robert E. Lee	do	67	17	4.5		56
Louisa	Stern-wheel steamer	101	25	5	4.5	280
Frank Sessoms	do	86.6	22.8	3.6	3	79
Gov. Safford	Side-wheel steamer	129.6	26	7.5		307
Merchant	do	147.7	29.6	5.4	5	405
Ruth	do	81	26	4	3.8	89
F. G. Burroughs	do	125	22	6	4.5	283
Jno. M. Cole	do	130	39.6	5	4.5	318
Wm. Elliott	do	101	31	6	4.5	171
Eutaw	do	156	29.8	7.8	7.4	547
Planter	do	155	32.8	9.1		499
Socastee	Barge	47	12	4	3.5	16
Enterprise	do	41.5	12	3.5	3	17
Willie	Yacht	40	9	4		6
Madge	do	35	7	2		3
Sprite	do	37	8	3		5
Leilah	do	40	8	3		5
Advance	do	25	5.5	1.5		2
Loretta	do	40	9	3		7
Almont	do	40	8	5		4
Pelican	do	30	7	2.5		3
Maria C	do	35	10	4.5		8

N 2.

IMPROVEMENT OF LITTLE PEDEE RIVER, SOUTH CAROLINA.

No work was done during the year except care and maintenance of plant. * * *

* * * It is proposed to expend the available balance and allotment to be made from the new appropriation in making a survey of localities on this river requiring improvement, with a view to revision, if found necessary, of the estimate for completing the project; also to clear the river of snags, etc.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$228.68
June 30, 1902, amount expended during fiscal year	187.38
July 1, 1902, balance unexpended	41.30
July 1, 1902, outstanding liabilities	25.80
July 1, 1902, balance available	15.50

For this improvement the following appropriations have been made:

By act of Congress—	
Of August 11, 1888	$5,000
Approved September 19, 1890	5,000
Approved July 13, 1892	5,000
Of August 18, 1894	4,000
Of June 3, 1896	3,000
Total	22,000

Total expenditures, including June 30, 1902, $21,958.70.

COMMERCIAL STATISTICS.

*   *   *   *   *   *   *

Articles.	Tons.	Value.
OUTWARD FREIGHTS.		
Naval stores	400	$12,000
Cotton	400	64,000
Lumber, timber, and cord wood	50,000	300,000
	50,800	376,000
INWARD FREIGHTS.		
Fertilizers	400	10,000
Miscellaneous	260	13,000
Grand total	51,460	399,000

List of vessels plying on Little Pedee River, South Carolina, during calendar year 1901.

Name.	Character.	Length.	Breadth.	Depth.	Loaded draft.	Gross tonnage.
		Feet.	*Feet.*	*Feet.*	*Feet. In.*	
Ruth	Side-wheel steamer	81	26	4	3 6	89
6 pole flats		65	14	3	2 6	30
Almount	Yacht	40	8	5		4

*   *   *   *   *   *   *

N 3.

IMPROVEMENT OF GREAT PEDEE RIVER, SOUTH CAROLINA.

No work was done during the year except care and maintenance of plant. The expenditures, $480.82, added to previous expenditures for maintenance, about $31,795.23, make the total expended for maintenance under the original project about $32,276.05.

*   *   *   *   *   *   *

* * * It is proposed to expend the available balance and the funds appropriated, * * * first snagging the river thoroughly from the mouth to Cheraw, and making a survey of the shoals between the railroad bridge and the mouth to determine maintenance work required.

*   *   *   *   *   *   *

Money statement.

July 1, 1901, balance unexpended		$785.64
Amount appropriated by river and harbor act approved June 13, 1902		22,500.00
		23,285.64
June 30, 1902, amount expended during fiscal year		480.82
July 1, 1902, balance unexpended		22,804.82
July 1, 1902, outstanding liabilities		27.20
July 1, 1902, balance available		22,777.62
Amount (estimated) required for completion of existing project		106,300.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$40,000.00	
For maintenance of improvement	5,000.00	
		45,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

For this improvement the following appropriations have been made:

By act of Congress—		By act of Congress—	
Approved June 14, 1880	$7,000	Approved July 13, 1892	$10,000
Approved March 3, 1881	6,000	Of August 18, 1894	6,000
Passed August 2, 1882	6,000	Passed June 3, 1896	12,000
Approved July 5, 1884	8,000	Approved March 3, 1899	4,000
Approved August 5, 1886	20,000	Approved June 13, 1902	22,500
Of August 11, 1888	20,000		
Approved September 19, 1890	12,500	Total	134,000

Total expenditures, including June 30, 1902, $111,195.18.

COMMERCIAL STATISTICS, 1901.

* * * * * * *

Articles.	Tons.	Value.
OUTWARD FREIGHTS.		
Naval stores	3,000	$100,000
Cotton	912	146,080
Lumber, timber, cordwood	150,000	1,200,000
Rice, rough	2,000	90,000
Total	155,912	1,536,080
INWARD FREIGHTS.		
Fertilizers	15,000	375,000
Miscellaneous	18,000	900,000
Grand total	188,912	2,811,080

List of vessels plying on Great Pedee River, South Carolina, during the calendar year 1901.

Name.	Character.	Length.	Breadth.	Depth.	Draft, loaded.	Gross tonnage.
		Feet.	*Feet.*	*Feet.*	*Feet.*	
Bayard Hopkins	Schooner	118	30	9	10	269
Wm. Linthicum	do	112	27.6	8	9.6	156
Robert McClintock	do	96	26.7	7.4	8	154
Puritan	do	85.5	28.7	7.3		116
Myra W. Spear	do	99.2	27.6	7.5		156
Chas. Linthicum	do	104	26.4	8.2	8.6	181
Venus	do	108	29.4	9.1	11.6	204

List of vessels plying on Great Pedee River, South Carolina, etc.—Continued.

Name.	Character.	Length.	Breadth.	Depth.	Draft, loaded.	Gross tonnage.
		Feet.	*Feet.*	*Feet.*	*Feet.*	
John T. Russel	Schooner	66.2	22.2	4.7	....	36
Merchant	Side-wheel steamer	147.7	29.6	5.4	5	405
John M. Cole	do	130	39.6	5	4.5	318
Louisa	Stern-wheel steamer	101	25	5	4.5	280
Frank Sessoms	do	86.6	22.8	3.6	3	79
Wm. P. Congdon	Screw tug	75.2	18	7.8	....	68
S. S. Brewster	do	77.5	18.5	7.6	....	50
Martha Helen	do	82	16.7	7.4	....	75
Bon Accord	do	67.3	14.4	5	....	42
Henry Lloyd	do	40.5	12.2	4.8	....	13
Fearless	do	58	11	4	....	18
Emma A. Twiggs	do	53	13.2	4.5	....	16
Pender	do	52.7	14.9	3.4	....	28
Bertie	do	49.5	9.8	3.5	....	16
Robert E. Lee	do	67	17	4.5	....	56
Willie	Yacht	40	9	4	....	[a]6
Madge	do	35	7	2	....	[a]3
Sprite	do	37	8	3	....	[a]5
Leilah	do	40	8	3	....	[a]5
Loretta	do	40	9	3	....	[a]7
Maria C	do	35	10	4.5	....	[a]8
Pelican	Naphtha launch	30	7	2.5	....	[a]3

[a] Approximate.

N 4.

IMPROVEMENT OF WINYAH BAY, SOUTH CAROLINA.

Jetty construction under continuing contract with Mr. R. G. Ross was continued. The contract approved June 10, 1897, provided for the completion of the jetty work on or before July 1, 1902; but, as it had become evident that the work could not be completed by the latter date, authority was granted June 7, 1902, to waive the time limit of completion for a reasonable period, the contractor to bear such extra expenses as may be properly chargeable to him under the contract. The contractor earned during the year $307,805.85. In the previous fiscal year he had earned $264,326.97.

The south jetty has been extended seaward to its proposed outer end, the crest being brought up to high-water level only, for reasons given in my last annual report; and a mound at the seaward end with crest 12 feet above mean low water has been practically completed. For 1,240 linear feet of the jetty near its shoreward end it has been raised to 10 feet above mean low water. Some settlement has occurred, particularly in the outer 5,000 feet. A number of mattresses were sunk on the north side of the jetty foundation, and some additional stone placed on mattresses sunk in former years.

The north jetty foundation mattress was completed. The stone superstructure was extended 2,747 linear feet, or nearly to its proposed seaward end, the crest being carried to about 6 feet above mean low water. The inner portion of this jetty, built under former contracts, was raised to the above height for a length of 2,725 feet.

The dredge *Winyah Bay* worked until August 5, 1901, removing 22,072 cubic yards of material, when she was sent to Key West, Fla., for emergency dredging work there. The dredge *Charleston* worked at Winyah Bay from August 21, 1901, to November 7, 1901, and from March 20, 1902, to June 18, 1902, when she was sent away for urgent repairs. She had dredged 143,304 cubic yards, making the total removed by both dredges 165,376 cubic yards. Dredging in the temporary channel nearly parallel to the north jetty was suspended in July, 1901, on account of the deepening of the South Jetty channel due to the rapid extension of the south jetty.

The accompanying map of survey just made, as compared with the map of survey which accompanied my annual report of last year, shows a gain in the ruling entrance depth from 12 feet to 13.9 feet at mean low water. It also shows a depth of 15 feet at mean low water extending entirely through the Middle Ground channel, though in a narrow and crooked course.

For details of the work, jetty work yet to be done under present contract, etc., reference is made to the accompanying report of Assistant Engineer Reid Whitford, who has been in local charge of the work.

The sundry civil act approved June 28, 1902, contains the following item:

> Improving Winyah Bay, South Carolina: For continuing improvement of harbor at Winyah Bay, thirty-five thousand dollars.

The following authorization is contained in the river and harbor act approved June 13, 1902:

> Winyah Bay, South Carolina: The dredge or dredges employed in connection with the work of improvement at the entrance to Winyah Bay, and such other dredges owned or controlled by the Government as are used on Winyah Bay river systems and canals, may be used in dredging the shoal places between the entrance and the city of Georgetown, South Carolina, over which the least channel depths may at any time be less than at the entrance of the bay; and any expense so caused shall be paid from amounts appropriated or that may be appropriated for said Winyah Bay: *Provided*, That the expense of said dredging, added to that of improving the entrance to said bay, shall not exceed the total amount appropriated and authorized to be appropriated by act of June third, eighteen hundred and ninety-six.

It is proposed to expend the available balance and additional appropriation recommended in completing the jetties, including works for the purpose of securing the shore end of the south jetty, to continue dredging in the entrance channel, and to deepen, by dredging, the shoal places in the bay between the entrance and the city of Georgetown, as above authorized.

* * * * * *

Money statement.

July 1, 1901, balance unexpended	$752,561.05
August 2, credited by Auditor's settlement No. 31207	33.76
Amount appropriated by sundry civil act approved June 28, 1902	35,000.00
	787,594.81
June 30, 1902, amount expended during fiscal year	395,517.37
July 1, 1902, balance unexpended	392,077.44
July 1, 1902, outstanding liabilities	83,723.19
July 1, 1902, balance available	308,354.25
July 1, 1902, amount covered by uncompleted contracts	182,091.92

Amount (estimated) required for completion of existing project		317,750.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$100,000.00	
For maintenance of improvement	60,000.00	
		160,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

Amount and date of all appropriations for this work are as follows:

By act of Congress—	
Approved August 5, 1886	$18,750.00
Of August 11, 1888	100,000.00
Approved September 19, 1890	100,000.00
Approved July 13, 1892	100,000.00
Of August 18, 1894	110,000.00
Passed June 3, 1896	20,000.00
Approved June 4, 1897	350,000.00
Approved July 1, 1898	450,000.00
Approved March 3, 1899	58,500.00
Approved June 6, 1900	285,000.00
Approved March 3, 1901	500,000.00
Approved June 28, 1902	35,000.00
Received on account of Treasury settlement No. 31207	33.76
Total	2,127,283.76

Total expenditures, including June 30, 1902, $1,735,206.32

LIST OF CONTRACTS IN FORCE.

Contract for—	Name of contractor.	Date of approval.	Date of beginning.	Date of completion.
Constructing jetties	R. G. Ross	June 10, 1897	July 1, 1897	July 1, 1902

EMERGENCY CONTRACTS.

Contract for—	Name of contractor.	Date of contract.	Date of beginning.	Date of completion.
500 tons steam coal	J. I. Hazard	Aug. 7, 1901	Aug. 8, 1901	Sept. 2, 1901
1,000 tons coal	do	Mar. 17, 1902	Mar. 27, 1902	Apr. 9, 1902
1 drag, 1 curved pipe, and patterns.	Riverside Iron Works	Mar. 24, 1902	Mar. 26, 1902	Apr. 20, 1902

COMMERCIAL STATISTICS, 1901.

* * * * * * *

Articles.	Tons.	Value.
OUTWARD FREIGHTS.		
Naval stores	19,334	$367,932
Cotton	3,525	564,000
Rice, rough and clean	9,360	580,467
Lumber, shingles, and cross-ties	171,094	1,090,507
Fish, game, and vegetables	1,900	190,000
Miscellaneous	1,243	1,665,000
Total	206,456	4,457,906
INWARD FREIGHTS.		
Miscellaneous	41,533	4,000,000
Grand total	247,989	8,457,906

List of vessels at and entering port of Georgetown, S. C., during calendar year 1901.

Name.	Character.	Length.	Breadth.	Depth.	Gross tonnage.
		Feet.	*Feet.*	*Feet.*	
Waccamaw	Screw steamship	256	42	11	1,359
Georgetown	do	256	42	14	1,359
Saginaw	do	238	34.3	17.1	1,835
Richmond	do	206	33	21.6	1,437
Oneida	do	205.8	29.9	18.6	1,322
Geo. W. Clyde	do	256	35	19.2	1,848
Wm. P. Congdon	Screw steamer	75.2	18.2	7.8	68
S. S. Brewster	do	77.5	18.5	7.6	50
Martha Helen	do	82	16.7	7.1	75
Bon-Accord	do	67.3	14.4	5	42
Henry Lloyd	do	40.5	12.2	4.8	13
Fearless	do	58	11	4	18
Emma A. Twiggs	do	53	13.2	4.5	16
Pender	do	52.7	14.9	3.4	28
Bertie	do	49.5	9.8	3.5	16
E. T. Williams	do	81	21	9	97
Robert E. Lee	do	67	17	4.5	56
Two Brothers	Stern wheel steamer	75.1	30.1	5.4	97
Louisa	do	101	25	5	280
Frank Sessoms	do	86.6	22.8	3.6	79
Merchant	Side-wheel steamer	147.7	29.6	5.4	405
Governor Safford	do	129.6	26	7.5	307
Ruth	do	81	26	4	89
F. G. Burroughs	do	125	22	6	283
John M. Cole	do	130	39.6	5	818
Wm. Elliott	do	101	31	6	171
Eutaw	do	156	29.8	7.8	547
Planter	do	155	32.8	9.1	499
Winyah	Schooner	43.2	16.4	6.1	18
Blanche Creamer	do	46.1	14.4	4	15
We Go	do	44	13.7	4.3	18
Hugh	do	47.6	14.2	3.4	14
Waccamaw	do	137.7	33.3	14.5	458
E. A. Danenhower	do	116.6	30.2	8.7	228
Nellie Floyd	do	136	33	15.4	457
Bayard Hopkins	do	118	30	9	269
Wm. Linthicum	do	112	27.6	8	156
Robert McClintock	do	96	26.7	7.4	154
Warren B. Potter	do	130	32.4	12	368
Chas. H. Sprague	do	122	30.7	9.5	318
Willie L. Maxwell	do	131.6	32.7	9.5	315
Puritan	do	85.5	28.7	7.3	116
Myra W. Spear	do	99.2	27.6	7.5	156
Geo. R. Congdon (lost)	do	133	32.4	14.8	458
Edward L. Martin	do	87.2	23.6	6.8	84
Rebecca R. Douglass	do	138.8	33.9	9.5	475
Percy & Lillie	do	141	33.5	14.1	503
Golden Ball	do	124.2	30.3	10.5	286
Chas. Linthicum	do	104	26.4	8.2	131
J. A. Beckman	do	140.7	34.2	16.1	485
Edward W. Young (lost)	do	149.5	34.4	12.3	424
Venus	do	108	29.1	9.1	204
Fannie Reiche	do	143.1	34	10.1	463
Sarah D. J. Rawson	do	140.5	34.8	11.1	387
John T. Russell	do	66.2	22.2	4.7	36
William Churchill	do	143.6	34.7	11	432
Abbie C. Stubbs	do	130	32.2	12	345
Etta	Sloop	17	11	3.3	8
Clipper	do	31	11	2.9	10
Leila	do	31	10	2.5	8
Liza Jane	do	40.8	12.5	4.9	17
Socastee	Barge	47	12	4	16
Enterprise	do	41.5	12	3.5	17
Willie	Yacht	40	9	4	*a*6
Madge	do	35	7	2	*a*3
Sprite	do	37	8	3	*a*5
Leilah	do	40	8	3	*a*5
Advance	do	25	5.5	1.5	*a*2
Loretta	do	40	9	3	*a*7
Husted	do	42	8	3	*a*5
Syra	do	36	7	3	*a*3
Thistle	do	43.6	11.5	3.9	13
Almont	do	40	8	5	4
Pelican	Naphtha launch	30	7	2.5	3
Wapella	do	30	7	2.5	3
Maria C	Yacht	35	10	4.5	8
Petrel	do	40	10	3.5	9

a Approximate.

The following letters are furnished by W. D. Morgan, mayor of Georgetown, and Mr. F. S. Farr, president Atlantic Coast Lumber Company:

LETTER OF MR. W. D. MORGAN, MAYOR OF GEORGETOWN, S. C.

Mayor's Office, *Georgetown, S. C., May 20, 1902.*

Dear Sir: Complying with request contained in yours 19th instant, I beg to hand you inclosed statement of volume of commerce of the port of Georgetown for the year 1901. By comparison with the year 1900, it shows an increase of over 25 per cent, one of the principal items of increase being the shipments of lumber. This showing is indeed gratifying, and only goes to prove the claims made when we were asking appropriations for the improvement of the ocean entrance to this port. The contemplated improvement of the ocean entrance to a depth of at least 15 feet at low water was the principal factor that induced the location and erection at Georgetown of the largest sawmill plant in this country, if not in the world. This plant is turning out at present about 150,000,000 feet annually. Two other sawmill plants turn out together about 30,000,000 feet annually. The exports of lumber the year of 1902 should be over 150,000,000 feet. The Atlantic Coast Steamship Company has fine steamships plying between this port, New York, Boston, Philadelphia, and other Northern and Eastern ports. Each of these ships carry about one and a quarter million feet of lumber at a load. The Clyde Steamship Company, of New York, also have a line of ships running to Georgetown, touching at Wilmington both ways. Lines of steamers are engaged in freighting on all the rivers tributary to Georgetown, and a movement is now on foot to establish a line of steamers between Georgetown and Columbia. This will open up a new field for business on both the Santee and Congaree rivers, and add materially to the commerce of this port. One of the obstacles to vessels of a deeper draft coming here at present, and the building up of a large foreign commerce, is the shallow condition of the inner Winyah Bay. There is a provision in the present river and harbor bill which, if it becomes a law, provides for a survey of Georgetown Harbor from the wharves to the ocean, to provide a clear channel of 18 feet at low water. With this improvement secured there is hardly a doubt but what the present commerce would soon be doubled, population greatly increased, new manufacturing enterprises started, and this become one of the progressive and important ports on the South Atlantic coast. The continued improvement of all the rivers tributary to Winyah Bay, and the completion of the Minim Creek Canal, should receive ample support at the hands of the Government, as the improvement of these natural highways of commerce cheapens freight rates and benefits the farmer, merchant, and manufacturer. Further, I remain,

Yours, very truly,

W. D. Morgan, *Mayor.*

Reid Whitford, Esq.,
United States Assistant Engineer.

LETTER OF MR. F. S. FARR, PRESIDENT ATLANTIC COAST LUMBER COMPANY.

Atlantic Coast Lumber Company,
Georgetown, S. C., May 20, 1902.

Dear Mr. Whitford: I beg to submit the following to verify the company's letter of a year ago.

We have now completed all of our mills, consisting of No. 1 with double-cutting band and resaw; No. 2 with two double-cutting bands and resaw; No. 3 with two double-cutting bands and gang, and No. 4 with double-cutting band. These four mills have a cutting capacity of 600,000 feet per day. We have also completed our planing mill, with 11 machines, having a capacity of 200,000 feet per day.

We have now completed 36 brick dry kilns, for the curing of the lumber, together with one shipping pier 1,600 feet long by 90 feet wide. We also have a storage shed on land 800 by 160 feet. We have direct connection by trolley between this storage shed and the shipping pier. We have also built an uncovered dock about 2,000 feet long. Our total output will be, as nearly as we can estimate, 180,000,000 feet per year.

We now own and have in commission four steamers, viz, the *Georgetown*, *Waccamaw*, *Katahdin*, and *Aragon*, with an average carrying capacity of 1,500,000 feet each. Owing to the present depth of the water, however, over both the outer and inner bars we are only able to load these ships with about 1,400,000 feet. We are also considering the purchase of the steamship *Radenscraig*—length of keel, 340 feet; beams, outside, 43 feet; mean draft, 16 feet; carrying capacity, 1,700,000 feet of lumber. Of course, with the present depth of water she could carry only about 1,500,000 feet. We have under charter at the present time twelve schooners with an average capacity of 400,000 feet each.

During the month of April we shipped 13,000,000 feet of lumber, and should have shipped 15,000,000 feet this month but have been unable to obtain vessels of sufficient capacity. We have about 20,000,000 feet of lumber in stock at the present time, whereas our stock should not be more than 7,000,000 feet, the accumulation having arisen by reason of inability to secure vessels of sufficient capacity to carry the lumber economically.

We have been considerably inconvenienced by not being able to load our steamers to their full capacity, owing to lack of water over both the outer bar and the inner bay, and I hope you will use your influence, and be successful in your effort, looking toward the deepening of the channel from this port to the Atlantic Ocean.

With best wishes, I am yours, very truly,

F. S. Farr, *President.*

Mr. Reid Whitford,
United States Assistant Engineer.

REPORT OF ASSISTANT ENGINEER REID WHITFORD.

United States Engineer Office,
Georgetown, S. C., June 30, 1902.

Captain: I have the honor to report as follows on improving Winyah Bay, South Carolina, for fiscal year ending June 30, 1902:

Under contract with R. G. Ross, work of constructing both the North and the South Jetty was carried on.

South Jetty.—Twelve thousand six hundred and ninety and sixty-seven one-hundredths square yards of mattress foundation was sunk along its northern edge where a tendency of undercutting the regular foundation matresses by the current was apparent, 6,897.26 tons of ballast stone being used to hold these mattresses firmly on the bottom.

On mattresses previously sunk on the axis of the main jetty, 8,080 tons were distributed over their surfaces to give additional weight.

Sixty thousand four hundred and eighty-two and forty-five one-hundredths tons of large or superstructure stone were placed on the main line of jetty, extending it to its seaward end 2,548 feet, or to station 237 + 23, making its total length 21,051 feet from its shoreward end on South Island beach, its height reaching to ordinary high-water level, except the last 5,000 feet, which has settled to about low water. At its extreme seaward end a mound of large stone was built up, with its crest about 12 feet above mean low water. At this time the mound has been nearly completed, only requiring the placing of some additional large stone to somewhat broaden its crest and strengthen its slopes.

During the year the South Jetty was extended 2,548 linear feet in superstructure seaward, and 1,240 linear feet of superstructure landward in its extension to the high-water line. On this landward extension, which is not yet completed, the crest of the jetty is approximately 10 feet above mean low water, with a width of 10 feet.

Owing to the shallowness of the water, preventing the floating of the heavier derrick lighters into position along the jetty, stone of the larger class could not be used shoreward nearer than station 34. From that point shoreward ballast or smaller kind was substituted, making a very compact shore terminus of the jetty, and of sufficient strength and weight to resist the force of the low waves running upon the beach. This work has not yet been completed, and so far there have been used for this purpose during the year 5,913.97 tons of stone. Four thousand eight hundred and sixty-seven and fifteen one-hundredths tons large stone were used between stations 42 + 50 and 113, filling in low places where the jetty has settled.

Where the jetty superstructure was built up, in the seaward extension, to about mean high-water level, some places have settled and stone toppled off the crest, and the jetty will have to be raised again to the required height for a distance of about 5,000 linear feet.

Total amount of stone used on the South Jetty for the year 86,240.83 tons, and 12,690.67 square yards of mattresses.

The following work therefore is left to be done on the South Jetty, to finish it under the present contract and in accordance with existing authorities: Complete mound at seaward end of jetty, and two other mounds, one on the jetty at the southern end of the Middle Ground channel, and the other, halfway between this and the extreme seaward end of jetty; build up the low places between this point and where the crest of the jetty is 6 feet above mean low water; complete its shoreward end to the high-water line on the beach.

North Jetty.—This was extended 2,747 linear feet in a due easterly direction, parallel to the South Jetty, toward its present adopted seaward terminal, using for this purpose 39,059.84 square yards mattress foundation, and 36,205.37 tons of ballast stone, and 41,938.03 tons of large or superstructure stone, the height of the crest being approximately 6 feet above mean low water.

At present the superstructure reaches within 192 feet of the jetty's sea terminal, which is at the outer end of the foundation mattresses.

At this outer end it is intended to erect a mound similar to the one on the end of the South Jetty.

On the old stonework done under previous contracts 12,882.03 tons of large stone were placed, raising this old portion to about 6 feet above mean low water, from station 10 at the sand beach, 2,575 feet seaward, to station 35 — 75, and also 150 feet from station 65 to 66 + 50, where the sand was washing across the low jetty.

Total tons stone used for the year 91,025.43, and 39,059.84 square yards of foundation mattresses. The jetty has a total length of 11,139 linear feet from its landward end on North Island to the outer foundation mattresses.

Before the North Jetty is finished under the present contract and existing authorities, it will be necessary to fill in 2,925 remaining feet of this old work done under previous contracts, complete its final seaward end, and erect a mound at this point.

In placing the large stone in cross section, it was so arranged as to make the crest as sharp and the slopes as steep as they would stand, in order that the superstructure might be hurried to the sea terminal of the jetty as rapidly as possible. This sharp crest does not apply to the shoreward extension, where it was made wider.

There was placed on both jetties during the year a total of 177,266.26 tons of stone and 51,750.51 square yards of mattresses. A dredge owned and operated by the United States continued operations on the North Jetty, the Middle Ground, and the South Jetty channels, without the service of which it would probably not have been possible to maintain sufficient depth to accommodate the growing commerce of the port.

The dredge removed from these channels a total of 165,376.47 cubic yards of material—of this only 17,807.89 cubic yards were taken from the North Jetty channel proper. As was expected, the South Jetty channel began deepening as soon as the superstructure of the South Jetty was extended farther seaward, and the North Jetty channel having given temporary relief while this shoaling of the South Jetty channel was going on, dredging operations were transferred to the South channel, the North being abandoned. There was no work done on the shoal within the bay at Beacon No. 1, as the weather did not prevent the dredge working on the South Jetty and Middle Ground channels at all times.

The accompanying tracing made from the annual survey of the entrance, just completed, shows a depth entirely through the Middle Ground channel of not less than 15 feet at mean low water, as the present project for this work requires, but needing a great deal more dredging to widen and deepen it in a suitable manner for safe navigation; but the controlling depth now is in the South Jetty channel, where a very narrow shoal has thrown itself across it, with only 13.9 feet at mean low water. A few days' work of a dredge would very probably remove this obstruction. Unfortunately the dredge had to be hauled off for urgent repairs on June 18.

Taking all things into consideration, there is a decided improvement shown by this year's map over that of last year, and while the one for last year indicated a controlling depth of 12 feet at mean low water, this one shows a depth of 13.9 feet at same stage of tide.

The tracing also shows the apron mattresses sunk on the north side of the South Jetty to prevent undercutting.

Of the total amount expended on the entire work, 8¾ per cent was for maintenance and 91¼ per cent for improvement.

Very respectfully, your obedient servant,

Reid Whitford,
Assistant Engineer.

Capt. J. C. Sanford,
Corps of Engineers.

N 5.

IMPROVEMENT OF SANTEE RIVER, SOUTH CAROLINA.

No work was done during the year except care and maintenance of plant.

* * * * * * *

It is proposed to apply the allotment to be made from the new appropriation to widening and deepening the Estherville-Minim Creek Canal in accordance with the project and to keeping the Santee River proper clear of snags.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$38.00
June 30, 1902, amount expended during fiscal year	38.00

For this improvement the following appropriations have been made:

By act of Congress—		By act of Congress—	
Approved March 3, 1881	$22,000	Approved July 13, 1892	$30,000
Passed August 3, 1882	20,000	Of August 18, 1894	40,000
Approved July 15, 1884	15,000	Passed June 3, 1896	48,000
Approved August 5, 1886	18,750	Approved March 3, 1899	20,000
Of August 11, 1888	24,000		
Approved September 19, 1890	30,000	Total	267,750

Total expenditures, including June 30, 1902, $267,750.

COMMERCIAL STATISTICS, 1901.

* * * * * * *

Articles.	Tons.	Value.
OUTWARD FREIGHTS.		
Naval stores	20,000	$334,000
Cotton	775	152,500
Lumber, timber, and cord wood	140,000	316,000
Rice and rice flour	26,000	120,000
Fish, game, and vegetables	50	2,500
Miscellaneous	350	34,000
Total	187,375	959,000
INWARD FREIGHTS.		
Miscellaneous	17,000	850,000
Grand total	204,375	1,809,000

The following letter regarding the commerce of the river and canal has been furnished by Mr. Louis S. Ehrich, of Georgetown, S. C.:

DEAR SIR: I beg to hand you herewith statement of statistics for Santee River for the past year, which I hope you will find in order. The past year was a very disastrous one for all who engaged in agricultural pursuits; in consequence of excessive rains the crops of all kinds were the poorest in twenty years. This will account for the large falling off in this statement as compared with my last. The timber interest alone flourished, and will continue to increase until the maximum quantity that can be drifted to Georgetown has been reached. Georgetown will this year probably ship more manufactured lumber than any port on the South Atlantic coast, and a good proportion of this will come from the Santee River. A new line of steamers will be put on during the summer, two boats having already been purchased that will very much increase the tonnage, as they will ply higher up the river than any of the steamers now reach. Further, I remain,

Yours, truly,
LOUIS S. EHRICH.

REID WHITFORD, Esq.,
United States Assistant Engineer.

List of vessels plying on Santee River, South Carolina, during calendar year 1901.

Name.	Character.	Length.	Breadth.	Depth.	Draft, loaded.	Gross tonnage.
		Feet.	*Feet.*	*Feet.*	*Feet.*	
Jno. M. Cole	Side-wheel steamer	130	39.6	5	4.5	318
Frank Sessoms	Stern-wheel steamer	86.6	22.8	3.6	3	79
Janie	Screw tug	42.8	10.5	4.5	....	17
Otto	.....do	31.3	11.2	3.7	....	10
Pender	.....do	52.7	14.9	3.4	....	28
Etta	Sloop	47	11	3.3	3	8
Flora Temple	.....do	34.8	12.8	3.3	3	7
We Go	Schooner	44	13.7	4.3	4	18
Hugh	.....do	47.6	14.2	3.4	3	14
Clipper	Sloop	31	11	2.9	2	10
Leila	.....do	31	10	2.5	2	8
Liza Jane	.....do	40.8	12.5	4.9	4	17
Eutaw	Side-wheel steamer	156	29.8	7.8	7.4	547
Willie	Yacht	40	9	4	....	6
Loretta	.....do	40	9	3	....	7
Gardinia	Stern-wheel steamer	75	12.6	3.2	3	34
Pelican	Yacht	30	7	2.5	....	3

N 6.

IMPROVEMENT OF WATEREE RIVER, SOUTH CAROLINA.

No work was done during the year except care and maintenance of plant. The expenditures were $412.87.

The river and harbor act approved June 13, 1902, appropriated $27,000 for improving the Santee, Wateree, and Congaree rivers. * * * As the above river and harbor act provides for a preliminary examination of the Wateree River with the proviso that "until further action by Congress improvement on said river is suspended," no further work will be done on the river until Congress so orders.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$632.28
June 30, 1902, amount expended during fiscal year	412.87
July 1, 1902, balance unexpended	219.41
July 1, 1902, outstanding liabilities	27.00
July 1, 1902, balance available	192.41

For this improvement the following appropriations have been made:

By act of Congress—		By act of Congress—	
Approved March 3, 1881	$8,000	Approved July 13, 1892	$2,500
Passed August 2, 1882	15,000	Of August 18, 1894	2,500
Approved July 5, 1884	5,000	Passed June 3, 1896	5,000
Approved August 5, 1886	7,500	Approved March 3, 1899	2,500
Of August 11, 1888	12,000		
Approved September 19, 1890	12,500	Total	72,500

Total expenditures, including June 30, 1902, $72,280.59.

COMMERCIAL STATISTICS, 1901.

* * * * * * *

Articles.	Tons.	Value.
OUTWARD FREIGHTS.		
Timber	10,417	$50,000

List of vessels plying on Wateree River, South Carolina, during calendar year 1901.

Name.	Character.	Length.	Breadth.	Depth.	Gross tonnage.
		Feet.	*Feet.*	*Feet.*	
Janie	Screw tug	42.8	10.5	4.5	17

N 7.

IMPROVING CONGAREE RIVER, SOUTH CAROLINA.

No work was done during the year except care and maintenance of plant. * * *

The river and harbor act approved June 13, 1902, appropriated $27,000 for improving the Santee, Wateree, and Congaree rivers. * * * It is proposed to expend the available balance and allotment to be made from the above appropriation in keeping the river clear of snags; in making a survey of the shoals to determine their present condition, with a view to revision, if found necessary, of the estimate for completing the project, and to deepen and widen the channel to the dimensions contemplated by the project, so far as funds will permit.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$326.18
June 30, 1902, amount expended during fiscal year	27.00
July 1, 1902, balance unexpended	299.18

For this improvement the following appropriations have been made:

By act of Congress—	
Approved August 5, 1886	$7,500
Of August 11, 1888	7,500
Approved September 19, 1890	5,000
Approved July 13, 1892	5,000
Of August 18, 1894	4,000
Passed June 3, 1896	2,000
Total	31,000

Total expenditures, including June 30, 1902, $30,700.82.

COMMERCIAL STATISTICS, 1901.

* * * * * * *

Articles.	Tons.	Value.
OUTWARD FREIGHTS.		
Timber	14,583	$70,000

There were no vessels plying on the Congaree River during the calendar year.

N 8.

IMPROVEMENT OF CONGAREE RIVER, SOUTH CAROLINA, FROM GERVAIS STREET BRIDGE, COLUMBIA, TO GRANBY.

Work of building the lock and abutment under the contract approved October 20, 1900, with the Evansville Contract Company was continued. * * *

The work was seriously delayed by numerous freshets, and a waiver of the original time limit for completion, January 30, 1902, was authorized by the Department January 11, 1902. The four leaves of the steel lock gates were built and are ready to be placed. Plans and specifications for 376 feet of Chanoine movable dam, without navigable pass, to extend from the lock to the abutment, were completed and submitted; and the plans were approved June 28, 1902.

For details of the work reference is made to the appended report of Assistant Engineer W. A. Leland, who has been in local charge of the work throughout the year.

The sundry civil act approved June 28, 1902, contains the following item:

> Improving Congaree River, South Carolina: For completing improvement from Gervais Street Bridge, Columbia, to Granby, fifty thousand dollars.

It is proposed to expend the available balance in completing the lock and movable dam and in clearing the channel between the lock and dam and Columbia of bowlders and other obstructions.

Money statement.

July 1, 1901, balance unexpended	$183,742.47
Amount appropriated by sundry civil act approved June 28, 1902	50,000.00
	233,742.47
June 30, 1902, amount expended during fiscal year	40,319.35
July 1, 1902, balance unexpended	193,423.12
July 1, 1902, outstanding liabilities	11,872.69
July 1, 1902, balance available	181,550.43
July 1, 1902, amount covered by uncompleted contracts	48,177.27

Amount and date of all appropriations for this work are as follows:

By act of Congress—	
Approved March 3, 1899	$50,000
Approved June 6, 1900	100,000
Approved March 3, 1901	50,000
Approved June 28, 1902	50,000
Total	250,000

Total expenditures to June 30, 1902, $56,576.88.

LIST OF CONTRACTS IN FORCE.

Contract for—	Name of contractor.	Date of approval.	Date of beginning.	Date of completion.
Constructing lock and abutment.	The Evansville Contract Co.	Oct. 20, 1900	Nov. 29, 1900	[a]Jan. 30, 1902
Steel and cast-iron members for four lock gates, wedge bolts, etc.	New Jersey Foundry and Machine Co.	Aug. 10, 1901	Aug. 10, 1901	[a]Oct. 9, 1901

[a] Time limit waived.

There is at present no navigation on this portion of the river, but it is reported that one or more steamboats will be put on within a few months.

REPORT OF MR. W. A. LELAND, ASSISTANT ENGINEER.

Columbia, S. C., *June 30, 1902.*

Captain: I have the honor to submit the following annual report of work done on Congaree River, from Gervais Street Bridge, Columbia, to Granby:

At the beginning of the fiscal year the Evansville Contract Company had installed most of the plant necessary to build the lock and abutment and had very nearly completed the cofferdam around the lock area. A small amount of earth and rock excavation had been removed and a part of the embankment finished.

Lock.—The cofferdam around the lock site was completed July 11, 1901, and work of blasting and removing rock from the lock area was started July 26 and was carried on, with many interruptions from freshets, until December, when 3,612 cubic yards had been removed, practically finishing this portion of the work. The upper and lower guide cribs to lock were completed and filled with stone. Concrete work on the lock commenced in December, when a portion of the lower wing wall was built. Frequent freshets delayed further work of this character until May, 1902, when work was started on the upper ends of both lock walls. About 75 feet of both walls have been completed and an additional 20 feet of both walls built up 5 feet from lock floor.

The plant for mixing and placing concrete was fully described in last annual report, and has been used as described, except that a traveling derrick working between the lock walls was substituted for the trestle along walls of lock.

Abutment.—Work was started on the abutment cofferdam March 13, 1902, and the abutment was completed May 20, except the earth filling between wing walls, which was placed in June. The face of this abutment is about flush with the low-water line of the river, and the walls extend back 70 feet into the bank and rest on bed rock 7 feet below water. The space between the walls was filled with clay and sand, except along the lower wing wall, where loose rock was piled, forming a blind drain to openings left in the walls for drainage.

The items of work done on this contract, with contract prices and totals of quantities and payments under it, are given in the following table:

Kind of work and material.	Price.	Done prior to July 1, 1901.		Done after July 1, 1901.	
		Quantities.	Cost.	Quantities.	Cost.
Earth excavation	$0.44 per cubic yard	1,304	$573.76	3,745	$1,647.80
Embankment	$0.59 per cubic yard	743	438.37	265	156.35
Rock excavation	$3.96 per cubic yard	50	198.60	3,582	14,184.72
Timber in permanent construction.	$40 per M, B. M			69,920	2,796.80
Sheathing	$35 per M, B. M			2,030	71.05
Stone filling	$1.58 per cubic yard			837	1,322.46
Puddle	$2.96 per cubic yard			102	301.92
Concrete	$7			2,128	14,896.00
Bolt holes in masonry	$0.50 per linear foot			23	11.50
Total			1,210.13		35,388.60

Work by hired labor.—Bids for steel members of lock gates were opened June 29, 1901, and contract was awarded the New Jersey Foundry and Machine Company. This company was exceedingly slow in furnishing the material, and the work of assembling the parts was delayed until January 28, 1902. A blacksmiths' shop was built in the meantime and fitted with tools, forges, etc., to do the assembling and riveting. This shop was made large enough to be used as a general storehouse when the lock is in operation. A derrick for handling the gate members was built between the shop and the railroad track. The beams and heel posts of leaf No. 1 were assembled January 28, 1902, and all of the sheets had been drilled and riveted in place and back braces riveted to beams and gusset plates by the end of February. Each of the subsequent leaves was completed in about three weeks. The lever arms for operating the gates are yet to be built. The valves for filling and emptying the lock, furnished by the New Jersey Foundry and Machine Company, were all from one-fourth to three-eighths inch longer than shown on plans and were chipped to the required dimensions here by the Government blacksmith, and the contractors were charged with the actual expense of this work.

Respectfully submitted.

W. A. Leland,
Assistant Engineer

N 9.

IMPROVEMENT OF THE INLAND WATERWAYS BETWEEN CHARLESTON HARBOR, SOUTH CAROLINA, AND OPPOSITE McCLELLANVILLE.

* * * * * * *

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902..	$50,000.00
July 1, 1902, balance unexpended	50,000.00
Amount (estimated) required for completion of existing project	75,290.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	50,000.00
Submitted in compliance with requiremen ts of sundry civil act of June 4, 1897.	

N 10.

IMPROVEMENT OF HARBOR AT CHARLESTON, SOUTH CAROLINA

No work was done on the jetties.

The sea-going suction dredge *Charleston* worked from the beginning of the year until August 6, and from November 9 to March 20. The somewhat similar dredge *Cape Fear* worked from December 3 to the end of the fiscal year, and the dredge *Winyah Bay* worked for about one-half day or November 27. The total amount of material removed during the year was 256,896 cubic yards. Whenever weather permitted the dredges worked on the outer bar. Here 174,968 cubic yards were removed from the eastern channel and 19,958 cubic yards from the old channel in prolongation of that between the jetties (maintenance). The work in the eastern channel was directed toward widening this channel mainly toward the southward, so as to give better entrance width and place its axis in a position where it could be conveniently lighted by range lights for the use of regular steamship lines. As none of these steamships draw over 20 feet, the distance between the 21-foot curves was first increased. It is now about 450 feet. The range lights were erected in June and first lighted on June 30. The material removed was largely soft mud, much of which was lost in the overflow, and the cuts were necessarily very short, for both of which reasons the number of yards removed is comparatively small. The 24-foot entrance channel, which is now being widened to the southward, has maintained itself well, the least depth being now 24.2 feet at mean low water (the mean range of tide is about 5.2 feet). Work on the inner shoal, near the inner entrance to the jetty channel, has been done only when storms made it impossible to work on the outer bar. From this shoal 61,970 cubic yards were removed. The accompanying map of survey shows that there is now a least depth of 26 feet through this shoal, a gain of 2 feet since last year's report. The 26-foot depth now extends from the city wharves to the ocean, except for about 3,000 feet on the outer bar, where the least depth is now 24.2 feet.

Under the contract, approved January 15, 1901, with the Petersburg Iron Works Company for the construction of a large seagoing suction dredge, at a cost of $144,300, the contract time for completion being November 24, 1901, the work has continued slowly. At the end of the year the hull was about 85 per cent completed, and should be ready for launching in July, 1902. The pumps, pumping engines, and boilers had been completed, but not installed. The propelling engine, shafting, etc., were about 69.5 completed, not counting installation. The dredge as a whole was about 70.3 per cent completed.

* * * * * * *

In view of the beginning of work, under extensive plans, on the new naval station at Charleston, it is important that an entrance channel not less than 26 feet deep at mean low water and 600 feet wide, as contemplated by the project referred to in the appropriation last-named above, should be obtained as quickly as possible consistent with proper economy. An estimate of $100,000 for work under the 26-foot project is, therefore, submitted below, as well as an estimate of $25,000 for maintenance.

* * * * * * *

Money statements.

26-FOOT PROJECT.

July 1, 1901, balance unexpended	$172,612.86
Amount appropriated by sundry civil act approved June 28, 1902	50,000.00
	222,612.86
June 30, 1902, amount expended during fiscal year	64,870.53
July 1, 1902, balance unexpended	157,742.33
July 1, 1902, outstanding liabilities	4,309.97
July 1, 1902, balance available	153,432.36
July 1, 1902, amount covered by uncompleted contracts	96,780.00
Amount (estimated) required for completion of existing project	158,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	100,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

21-FOOT PROJECT.

July 1, 1901, balance unexpended	$17,144.65
Amount appropriated by river and harbor act approved June 13, 1902	45,000.00
	62,144.65
June 30, 1902, amount expended during fiscal year	17,144.65
July 1, 1902, balance unexpended	45,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	25,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

For this improvement the following appropriations have been made:

By act of Congress—		By act of Congress—	
Approved June 18, 1878	$200,000	Approved July 13, 1892	$225,000
Approved March 3, 1879	200,000	Approved March 3, 1893	750,000
Approved June 14, 1880	170,000	Approved August 18, 1894	450,000
Approved March 3, 1881	175,000	Approved March 2, 1895	500,000
Passed August 2, 1882	300,000	Approved June 6, 1900	220,000
Approved July 5, 1884	250,000	Approved June 13, 1902	45,000
Approved August 5, 1886	187,500	Approved June 28, 1902	50,000
Of August 11, 1888	350,000		
Approved Sept. 19, 1890	370,000	Total	4,442,500

Total expenditures to June 30, 1902, $4,239,757.67.

LIST OF CONTRACTS IN FORCE.

Contract for—	Name of contractor.	Date of approval.	Date of beginning.	Date of completion.
Constructing wooden hull seagoing suction dredge complete.	Petersburg Iron Works Co..	Jan. 15, 1901	Jan. 31, 1901	[a] Nov. 24, 1901

[a] Time limit waived.

Emergency contracts.

Contract for—	Name of contractor.	Date of contract.	Date of beginning.	Date of completion.
Berth for dredge, storage for coal, storeroom, and labor for handling coal.	Consumers Coal Co..........	Dec. 1, 1901	Dec. 1, 1901	Sept. 1, 1902
Schooner load of coal.......	.....do......................	Jan. 14, 1902	Jan. 16, 1902	Jan. 22, 1902
New River coal.............	.....do......................	Mar. 25, 1902	Mar. 26, 1902	Oct. 26, 1902

COMMERCIAL STATISTICS.

[Does not include trade between Charleston and other points in same collection district.]

Arrivals and clearances of vessels and commerce at Charleston, S. C., from January 1 to December 31, 1901.

	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
Arrived.....	[a] 428	789,279	20,573	17	4,494	161	69	104,840	1,581	514	898,613	22,315
Cleared.....	[b] 99	130,677	2,053	10	2,789	114	23	28,880	463	132	162,346	2,630

[a] Of these, 16 vessels (tonnage 34,127), with crews numbering 422, were foreign.
[b] Of these, 62 vessels (tonnage 107,879), with crews numbering 1,509, were foreign

Coastwise vessels are not required to enter or clear.

Commerce (foreign), 1901.

Value of exports	$3,767,625.00
Value of imports	1,509,132.00
Duties collected	29,838.31

* * * * * * *

Commerce through Charleston Harbor, ocean entrance.

[Calendar year 1901.]

IMPORTS.

Articles.	Tons of 2,000 pounds.	Value.
Brimstone	1,112	$26,668
Muriate of potash	6,836	273,440
Kainit	78,380	658,892
Nitrate of soda	13,390	669,500
Sulphate of potash	660	29,040
Guano	800	16,701
Sulphate of ammonia	1,001	97,177
Manure salt	7,404	96,252
Pyrites	104,221	651,367
Tankage (blood and garbage)	3,800	76,011
Fish scrap	9,690	163,567
Manipulated fertilizer	3,712	48,256
Cotton, upland	1,215	208,980

Commerce through Charleston Harbor, ocean entrance—Continued.

IMPORTS—Continued.

Articles.	Tons of 2,000 pounds.	Value.
Coal	105,097	$421,597
Salt	9,716	87,123
Rice (rough)	6,400	315,000
Cotton ties	806	28,577
Jute	5,000	206,250
Lubricating and refined oil, gasoline, and naphtha	4,840	155,150
Fruit	1,431	32,155
Cocoanuts	420	9,665
Cement, lime, and plaster	22,300	207,000
Miscellaneous	105,500	10,468,000
Total	493,731	14,945,868

EXPORTS.

Lumber	139,911	506,176
Phosphate rock	27,865	87,561
Manipulated fertilizer	6,922	95,117
Clay	27,440	214,749
Cotton, upland	52,494	9,028,876
Cotton, sea-island	1,065	530,677
Cotton goods	6,375	2,550,000
Cotton-factory sweepings and lint	1,422	113,760
Cotton-seed oil	7,348	685,816
Cotton seed	1,029	18,960
Cotton-seed meal	3,490	83,772
Rice	1,280	64,050
Rosin	2,170	27,783
Turpentine	470	54,050
Miscellaneous	11,800	447,300
Total	291,081	14,508,647

These commercial statistics do not include a large part of the business of Charleston which is done by the railroads, nor do they include the commerce passing over the rivers which enter the harbor, nor over the inland routes to the North and South. The commerce to and from Charleston through Wappoo Cut alone amounted to 177,320 tons, valued at $2,732,600, in the calendar year 1901.

The regular lines of steamships established between this and other ports comprise a total of 15 steamships, of which 7 have been added during the past fiscal year.

REPORT OF MR. JAMES P. ALLEN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston, S. C., June 30, 1902.

CAPTAIN: I have the honor to submit the following annual report for Charleston Harbor, South Carolina:

Surveys of the outer channels were made October 21 and 24, 1901. Soundings beyond the jetty ends were taken November 7, 9, 13, and December 19, 1901. The eastern channel was surveyed again November 26. A few soundings were taken near the bell buoy in the old channel December 24 to determine progress of dredging. The inner shoal was sounded December 27, 1901, to January 6, 1902. Soundings just beyond outer ends of jetties were taken February 5–19 and March 7, the latter being in the eastern channel. The eastern channel was again sounded May 6 and 24.

The annual survey covering the inner shoal, the area between the jetties and that beyond their outer ends, was made between April 25 and June 17, 1902, and soundings were taken at the critical point of the eastern channel on July 3, 1902.

The dredge *Charleston* worked at this harbor through the month of July, 1901, and until August 6. On August 20 she went to Winyah Bay, where she remained working in the place of the dredge *Winyah Bay* until November 8. She then resumed work in the eastern channel at Charleston, and continued working at Charleston Harbor until March 20, 1902, when she was again sent to Winyah Bay.

The dredge *Winyah Bay*, which had been loaned to Key West from August 9 to November 22, 1901, returned to Charleston on the latter date, and after undergoing some repairs was sent to Jacksonville, Fla., November 28, by order of the Chief of Engineers. She did a part of one day's work at Charleston on November 27.

The dredge *Cape Fear* arrived at Charleston on December 2, and with the exception of a few days for minor repairs from time to time and twenty days lost on account of repairs made on the marine railway at Jacksonville, Fla., she worked continuously from that time to the end of the fiscal year.

The work of these dredges has been directed toward deepening and widening the channel through the inner shoal, widening the eastern channel, and maintaining the old entrance channel.

Recently the range of the eastern channel has been changed slightly toward the south, and has been lighted. The lights were shown first on the evening of June 30, 1902.

The following quantities have been removed:

Name of dredge.	Eastern channel.	Inner shoal.	Maintenance.
	Cu. yds.	*Cu. yds.*	*Cu. yds.*
Charleston	97,877	22,614	3,696
Winyah Bay	503		
Cape Fear	76,588	39,356	16,262
Total	174,968	61,970	19,958

The total cubic yards moved during the fiscal year by all dredges was 256,896, making the total removed from the beginning of the project 4,050,199 cubic yards.

The material dredged on the outer shoal has been largely mud. The measured yardage is consequently small, as this material settles so slowly in bins that much of it is lost in the overflow.

There is shown in 1902 a channel of at least 26 feet depth at mean low water, through from the harbor to the ocean, except that on the new lighted range of the eastern channel there is a distance of about 3,000 feet where less than 26 feet is shown. The area of over 26 feet depth in this eastern channel is much larger than last year. A 24-foot channel is shown all the way through from the harbor to the ocean. This has a good width except at one point, where dredging to widen it is now in progress. The old entrance channel near the range of Sumter light and St. Philip's Church has shoaled somewhat, and less than 19 feet at mean low water is now shown there. The width of the 26-foot channel between the jetties has generally increased. At a point about one-half a mile inside of the jetty ends the northern shoal shows a tendency to encroach upon the channel, and it is narrower at this point than it was at the same place last year. The width between the 26-foot curves is 250 feet, however, while last year it was only 200 feet wide a short distance farther inside. The narrow place seems to have moved outward.

The area between the channel and the south jetty has deepened and a somewhat larger area of water over 18 feet is shown than on the map of last year. There is no decided change in the depths over the area between the channel and the north jetty except near the jetty ends. The curves between the jetties and near their outer ends show movement seaward, but just at the ends of the jetties very little movement is shown. The exterior slope of the shoal seems to have become steeper at this point. The curves on the outer shoal have moved seaward generally, but no outward movement is shown in the 26-foot curve. The area of less than 12 feet is now very small, and the area of less than 18 feet on the main portion of the outer shoal is smaller than it was last year by about 7 per cent of the larger area. The area less than 21 feet at low water beyond the jetties and between the prolongations of their inner edges was 153 acres in June, 1897, 144 acres in January, 1898, and 129 acres in 1902. The area less than 18 feet was 82 acres in 1897, 77 in January, 1898, and 67 in 1902. The area less than 12 feet was 8 acres in 1897, 6 in 1898, and less than 1 acre in 1902. The 18 and 21 foot curves north of the eastern channel have withdrawn from the center line of the channel, due to dredging in this channel, and thus widening the channel for these depths. In the case of the 18-foot channel this increase of width is very marked. We have now a 21-foot channel at mean low water which is nowhere less than 450 feet wide. On the inner shoal there is no lump of less than 18 feet shown in the area between the old lighted range and the new. A narrow channel of not less than 26 feet at mean low water goes through this shoal, but this is not directly on the lighted range.

Respectfully submitted.

JAMES P. ALLEN, *Assistant Engineer.*

Capt. J. C. SANFORD,
Corps of Engineers.

N 11.

IMPROVEMENT OF WAPPOO CUT, SOUTH CAROLINA.

No work was done during the year, no funds being available.

The river and harbor act approved June 13, 1902, contains the following item:

Improving Wappoo Cut, South Carolina: Continuing improvement, eight thousand dollars.

It is proposed to expend the above appropriation and additional appropriation recommended in widening and deepening the cut across the Ashley River bar and such other portions of the channel as are now deficient in width and depth, and in maintaining the project width and depth.

* * * * * * *

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902		$8,000.00
July 1, 1902, balance unexpended		8,000.00
Amount (estimated) required for completion of existing project		17,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$10,000.00	
For maintenance of improvement	3,000.00	
		13,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

For this improvement the following appropriations have been made:

By act of Congress—		By act of Congress—	
Approved March 3, 1881	$10,000	Approved July 13, 1892	$10,000
Passed August 2, 1882	10,000	Of August 18, 1894	7,000
Approved July 5, 1884	3,000	Passed June 3, 1896	2,500
Approved August 5, 1886	5,000	Approved June 13, 1902	8,000
Of August 11, 1888	5,000		
Approved September 19, 1890	10,000	Total	70,500

Total expenditures, including June 30, 1902, $62,500.

COMMERCIAL STATISTICS, 1901.

* * * * * * *

Articles.	Tons.	Value.
Fertilizers	23,260	$210,000
Cotton	1,112	609,900
Vegetables	10,300	464,000
Rice	6,878	344,000
Lumber	64,770	183,700
Miscellaneous	71,000	921,000
Total	177,320	2,732,600

N 12.

IMPROVEMENT OF THE INLAND WATERWAY BETWEEN CHARLESTON AND BEAUFORT, SOUTH CAROLINA.

* * * * * * *

A project for the expenditure of the above appropriation will be submitted as soon as practicable.

* * * * * * *

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902	$30,000.00
July 1, 1902, balance unexpended	30,000.00
Amount (estimated) required for completion of existing project	31,600.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	20,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

N 13.

IMPROVEMENT OF BEAUFORT RIVER, SOUTH CAROLINA.

No work has been done, the only expenditures, $3.95, being in connection with collection of commercial statistics.

The river and harbor act approved June 13, 1902, contains the following item:

> Improving Beaufort River, South Carolina: For maintenance, two thousand dollars.

It is proposed to expend the available balance and additional appropriation recommended in making a survey to determine condition of the channel and in restoring the width and depth, so far as funds will permit, where deterioration has occurred.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended		$411.20
Amount appropriated by river and harbor act approved June 13, 1902		2,000.00
		2,411.20
June 30, 1902, amount expended during fiscal year		3.95
July 1, 1902, balance unexpended		2,407.25
Amount (estimated) required for completion of existing project		9,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$9,000.00	
For maintenance of improvement	2,000.00	
		11,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

For this improvement the following appropriations have been made:

By act of Congress—	
Approved September 19, 1890	$12,500.00
Approved July 13, 1892	12,500.00
Of August 18, 1894	5,000.00
Passed June 3, 1896	1,000.00
Approved June 13, 1902	2,000.00
Total	33,000.00

Total expenditures to and including June 30, 1902, $30,592.75.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels and commerce at Beaufort, S. C., from January 1 to December 31, 1901.

Year.	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
Arrived	17	23,274	384	.....	....	....	7	9,808	151	21	33,082	535
Cleared	6	8,897	129	.....	....	....	18	24,384	407	24	33,281	536

Value of exports	$166,189.00
Value of imports	136,639.60

N 14.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

Nothing has been done during the year beyond an examination of the "inland passage" between Charleston and Beaufort, S. C., to determine whether or not the passage was obstructed by sunken logs. A few sunken logs were found, the amount of obstruction being comparatively small. The ownership of the logs could not be determined. The logs will be removed when the plant is employed on other work in the vicinity. It is proposed to apply the balance, $1,361.58, from the allotment of $2,000 made April 26, 1900, to the removal of such obstructions of this kind as may be reported and to securing compliance with the law regarding obstructions.

N 15.

CONSTRUCTION OF SEAGOING HYDRAULIC DREDGES.

DREDGE FOR IMPROVING PASSES OF THE MISSISSIPPI RIVER.

Plans and specifications having been approved, the work was advertised July 4–August 13, 1901. Contracts with the William R. Trigg Company, of Richmond, Va., for constructing the hull and propelling machinery, including electric-light plant, for $254,555, and for constructing and installing the pumping machinery, for $32,050, were approved October 28, 1901, the time limit on both contracts being February 28, 1903. The contracts contemplate the construction of a steel hull, twin-screw dredge, 260 feet in length between perpendiculars, 47½ feet molded beam and 23 feet molded depth, bin capacity about 1,930 cubic yards, with two centrifugal pumps having 20-inch suctions.

The material for the hull, about 3,200,000 pounds of steel, was promptly ordered, and at the close of the year had practically all been received. Work was started at the place of erection November 4, 1901, on the supports for the ways and dredge. This site being on ground newly built up by material dredged from the river, and having never before been used, a large amount of preliminary work was necessary in the way of pile driving for the supports and of erecting an electric traveling crane to handle and place the material. The latter was not completed ready for use until nearly the end of June. The first keel plate was laid March 12, and the first shell plate placed June 23. At the end of the year all the outer, inner, and vertical keel plates, except two outer and two vertical plates, were in place, with top and bottom keel bars and floor clips, and were about one-half riveted. Five frames had been erected and 4 strakes of midship shell plating. One hundred and sixty half frames and floors had been riveted together ready to erect. The shopwork on a large quantity of material, consisting mainly of frames, floors, deck beams, midship shell plating, main and lower deck plating and bulkheads, had been completed. For this reason rapid work in erecting is hereafter to be expected. On July 11, 1902, 62 half frames and 141 deck beams were in place.

Work on the propelling machinery began in February, 1902, and fair progress has been made. Work on four boilers began in June, 1902, and on June 30 they were about 28 per cent completed. The pumping machinery, begun in April, was about 50 per cent completed at the close of the year. Counting all material gotten out specially for this work and all shopwork done, the dredge as a whole was about 33.8 per cent completed.

Money statement.

June 30, 1902, amount expended during fiscal year	$63, 897. 62
July 1, 1902, outstanding liabilities	15, 713. 30
July 1, 1902, amount covered by uncompleted contracts	210, 238. 50

LIST OF CONTRACTS IN FORCE.

Contract for—	Name of contractor.	Date of approval.	Date of beginning.	Date of completion.
Steel hull seagoing suction dredge with propelling machinery and electric-light plant.	William R. Trigg Co.	Oct. 28, 1901	Nov. 30, 1901	Feb. 28, 1903
Constructing and installing pumping machinery for seagoing suction dredge.	William R. Trigg Co.	do	do	do

DREDGE FOR IMPROVING CUMBERLAND SOUND, GEORGIA AND FLORIDA.

Plans and specifications having been approved, the work was advertised July 6–August 14, 1902. A contract with George A. Gilchrest, of Belfast, Me., for constructing the hull and propelling machinery, the consideration being $124,250, and the contract time for completion being August 5, 1902, was approved November 2, 1901. All proposals for constructing the pumping machinery were rejected as excessive, and emergency contracts entered into with Joseph Edwards & Co., of New York, for constructing the pumps and pumping engines for $10,000, and with the Bath Iron Works, Limited, of Bath, Me., for constructing the remaining pumping machinery and for installing all for $10,500, the time limits of these being so fixed as to insure the completion of this work at the same time with that of the hull and propelling machinery. The contracts contemplate the construction of a wooden hull, single-screw dredge, 185 feet in length between perpendiculars, 40 feet molded beam, and 20 feet molded depth, bin capacity somewhat over 1,100 cubic yards, with two centrifugal pumps having 18-inch suctions.

In November and December, 1902, the keel, shoe, propeller post, rudder post, stem, and apron were built. On account of the failure of certain subcontractors for frame timber, the contractor was obliged to send the shipyard foreman in January with a gang of men from Belfast into the woods to cut much of this timber. In March the afterbody frame was erected and 26 of the forward body frames. The framing was completed early in April. On March 11 a schooner arrived bringing all the yellow pine required. Much progress was made on the joiner work during the winter. At the close of the year the ceiling was completed, outside planking nearly completed, lower deck completed, main deck one-half planked and calked, bins about one-half completed, afterhouse about one-half completed, forward house about one-fourth completed, foundations for main engine and windlass practically completed, and much minor work done. The hull was 61.1 per cent completed, and hull and propelling machinery together 59.6 per cent.

Work on the propelling machinery had been somewhat delayed by an accident at the foundry and by a strike of the molders; but had nearly kept pace with the hull work. The boilers were well advanced toward completion.

The pumps and pumping engines had been completed and delivered. The dredge as a whole was 57.7 per cent completed.

Money statement.

June 30, 1902, amount expended during fiscal year	$61,447.81
July 1, 1902, outstanding liabilities	13,265.27
July 1, 1902, amount covered by uncompleted contracts	82,625.00

LIST OF CONTRACTS IN FORCE.

Contract for—	Name of contractor.	Date of approval.	Date of beginning.	Date of completion.
Constructing wooden hull, seagoing suction dredge and constructing and installing propelling machinery.	George A. Gilchrest	Nov. 2, 1901	Dec. 5, 1901	Sept. 5, 1902

EMERGENCY CONTRACTS.

Contract for—	Name of contractor.	Date of contract.	Date of beginning.	Date of completion.
Constructing pumping engines and dredging pumps.	Joseph Edwards & Co.	Oct. 22, 1901	Nov. 2, 1901	May 2, 1902
Furnishing certain parts of pumping machinery and installing all pumping machinery on dredge.	Bath Iron Works	Dec. 2, 1901	Depending on completion and delivery of pumps and engine, Jos. Edwards & Co., above.	

APPENDIX O.

IMPROVEMENT OF RIVERS AND HARBORS IN EASTERN GEORGIA; OF INSIDE WATER ROUTE BETWEEN SAVANNAH, GEORGIA, AND FERNANDINA, FLORIDA, AND OF CUMBERLAND SOUND, GEORGIA AND FLORIDA.

REPORT OF CAPT. CASSIUS E. GILLETTE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Savannah Harbor, Georgia.
2. Savannah River below Augusta, Georgia.
3. Savannah River, above Augusta, Georgia.
4. Darien Harbor, Georgia.
5. Doboy Bar, Georgia.
6. Altamaha River, Georgia.
7. Oconee River, Georgia.
8. Ocmulgee River, Georgia.
9. Brunswick Harbor, Georgia.
10. Inside water route between Savannah, Georgia, and Fernandina, Florida.
11. Cumberland Sound, Georgia and Florida.
12. Removing sunken vessels or craft obstructing or endangering navigation.

United States Engineer Office,
Savannah, Ga., July 18, 1902.

General: I have the honor to transmit herewith my annual report for the fiscal year ending June 30, 1902, upon the works of the river and harbor improvements in my charge.

Very respectfully,

Cassius E. Gillette,
Captain of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A

O 1.

IMPROVEMENT OF SAVANNAH HARBOR, GEORGIA.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1902.

Work during the year has been entirely for maintenance.

Dredging operations on Tybee knoll were begun by the Government dredge *Cape Fear* on August 15, 1901, and continued until November 29, 1901, 91,853 cubic yards of material being removed.

Bids for dredging in the lower portion of the harbor were opened September 16, 1901, and a contract made October 9, 1901, with P. Sanford Ross, Incorporated, at 14.9 cents per cubic yard. Work was begun December 16, 1901, and up to the close of the fiscal year 146,210.8 cubic yards of material had been removed.

Bids for dredging in the upper portion of the harbor were opened January 16, 1902. All bids were rejected as excessive. The work was readvertised and bids were opened March 3, 1902. Contract was made March 24, 1902, with George T. Warner, at 16 cents per cubic yard. Work was begun April 27, 1902, and up to the close of the fiscal year 52,170.1 cubic yards of material had been removed, besides 14 logs encountered in dredging.

Altogether 198,380.9 cubic yards of material were dredged during the year. The dredged localities are shown on the accompanying map.

COMMERCE AND NAVIGATION.

Full discussions of the commerce of Savannah were given in the reports of the Chief of Engineers for 1890, pages 1252 and 1253, and for 1897, page 1497.

The regular lines of steamships established between this port and New York, Baltimore, and Philadelphia comprise a total of 14 steamers, of which 6 run to the first-named port, making an occasional trip to Boston, and 8 to the last-named two. During the calendar year 1901 they made 429 round trips and carried 825,560 tons of freight. Two steamships have recently been added to the line between Savannah and New York.

On the inland waters there are a number of small steamers plying between Savannah and adjacent ports, besides numerous schooners and small sailboats. It is estimated that for the year 1901 this portion of the commerce amounted to 180,000 tons, valued at $1,800,000.

The chief articles of export are cotton, lumber, and naval stores, of which the shipments for the year 1901 were as follows: Of cotton, 1,085,376 bales; of lumber, 172,267,960 feet; and of naval stores, 314,876 barrels of turpentine and 1,062,637 barrels of rosin.

During the year 1901, 64,414 passengers were carried.

The total tonnage of the port, inward and outward bound, coastwise and local, during 1901, was 2,843,261 tons, valued at $158,495,188, the gain in tonnage over the previous year being 709,658 tons.

On November 21, 1900, a Board of Engineer officers submitted a report on a reexamination of the project of June 3, 1896, calling for 28 feet at mean high water. This report is found printed in House Ex. Doc. No. 123, Fifty-sixth Congress, second session, and also in the Report of the Chief of Engineers for 1901, page 1723.

The act of Congress approved June 13, 1902, adopted this report and appropriated $1,000,000 to carry out the work.

It is proposed to apply the available balance to the furtherance of this project.

The execution of this project being almost entirely dredging, it should be done as rapidly as possible, and if practicable at all the shoals at once, so that the new conditions of tidal flow may obtain at all points as nearly the same time as possible. For this reason the entire amount should, if possible, be made available by the close of the fiscal year ending June 30, 1903.

Money statement.

July 1, 1901, balance unexpended		$439, 708. 94
Amount appropriated by river and harbor act approved June 13, 1902.		50, 000. 00
		489, 708. 94
June 30, 1902, amount expended during fiscal year		52, 841. 31
July 1, 1902, balance unexpended		436, 867. 63
July 1, 1902, outstanding liabilities		13. 728. 17
July 1, 1902, balance available		423, 139. 46
July 1, 1902, amount covered by uncompleted contracts		14, 242. 38
Amount (estimated) required for completion of existing project		1, 000, 000. 00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$1, 000, 000. 00	
For maintenance of improvement	50, 000. 00	
		1, 050, 000. 00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

AMOUNT AND DATE OF ALL APPROPRIATIONS.

From 1826 up to the date of the 22-foot plan of improvement appropriations amounting to $667,096.64 were made for the improvement of the harbor and for the removal of wrecks, as follows:

By act of Congress of—		By act of Congress of—	
March 18, 1826	$50, 000. 00	August 30, 1852	$40, 000. 00
March 3, 1829	24, 490. 00	March 3, 1855	161, 000. 00
July 3, 1832	25, 000. 00	June 10, 1872	50, 000. 00
March 2, 1833	43. 06	March 3, 1873	50, 000. 00
March 2, 1833	8, 430. 62	February 27, 1874	193, 132. 96
June 28, 1834	30, 000. 00		
March 3, 1835	20, 000. 00	Total	667, 096. 64
July 7, 1838	15, 000. 00		

Under the 22-foot plan of improvement the following appropriations were made:

By act of Congress of—	
June 23, 1874	$50, 000. 00
March 3, 1875	70, 000. 00
August 14, 1876	62, 000. 00
June 18, 1878	70, 000. 00
March 1, 1879	100, 000. 00
June 14, 1880	65, 000. 00
March 3, 1881	65, 000. 00
August 2, 1882	200, 000. 00
July 5, 1884	200, 000. 00
August 5, 1886	150, 000. 00
August 11, 1888	180, 000. 00
	1, 212, 000. 00
Unexpended balance of last appropriation carried to new project	4, 035. 05
Total	1, 207, 964. 95

Under the 26-foot plan of improvement the following appropriations have been made:

By act of Congress of—	
August 11, 1888 (unexpended balance)	$4,035.05
September 19, 1890	350,000.00
July 13, 1892	318,750.00
March 3, 1893	1,000,000.00
August 18, 1894	975,000.00
March 2, 1895	856,250.00
	3,504,035.05
Amount deposited by clerk of United States circuit court for the southern district of Georgia, March 20, 1895	500.00
	3,504,535.05
Unexpended balance of last appropriation carried to modified project.	44,485.06
Total	3,460,049.99

Since the existing project for improving Savannah Harbor was adopted the following appropriations have been made:

By act of Congress of—		
March 2, 1895 (unexpended balance)		$44,485.06
June 3, 1896		5,000.00
June 4, 1897		350,000.00
July 1, 1898		450,000.00
March 3, 1899	$200,000.00	
	50,000.00	
		250,000.00
June 13, 1902		50,000.00
		1,149,485.06
Amount deposited to credit of the appropriation		301.41
Total		1,149,786.47
Grand total of appropriations		6,484,898.05

Contracts in force.

Name and address of contractor.	Character of work.	Rate.	Date of approval.	Work begun.	Expires.
		Cents.			
P. Sanford Ross, Incorporated, Jersey City, N. J.	Dredging	14.9	Nov. 2, 1901	Dec. 16, 1901	Aug. 11, 1902
George T. Warner, Savannah, Ga.	do	16	Apr. 18, 1902	Apr. 27, 1902	Sept. 27, 1902

COMMERCIAL STATISTICS.

Cotton statistics of the port of Savannah, Ga., for the commercial year ending August 31, 1901, are as follows:

Receipts from all sources.

Grade.	Quantity.	Weight.	Value.
	Bales.	*Pounds.*	
Upland	1,018,025	513,369,647	$50,127,551
Sea-island	64,797	25,401,719	5,058,701
Total	1,082,822	538,771,366	55,186,252

Exports from Savannah.

Destination.	Upland.	Sea-island.
	Bales.	*Bales.*
Coastwise	280,466	45,564
Great Britain	156,962	17,156
France	22,434	1,465
Other continental ports	557,026	735
Mill consumption and burned	1,851	....
Reshipped to interior	631	1,086
Total	1,019,370	66,006

Total exports.

Grade.	Foreign exports.	Coastwise exports.	Total.
	Bales.	*Bales.*	*Bales.*
Upland	736,422	280,466	1,016,888
Sea-island	19,356	45,564	64,920
Total	755,778	326,030	1,081,808

Steamship lines.

Line.	Steamers.	Voyages.	Freight.
Ocean Steamship Co.:			*Tons.*
Savannah to Boston	....	9	11,604
Savannah to New York	6	182	423,872
Merchants and Miners' Transportation Co.:			
Savannah to Baltimore	6	154	248,038
Savannah to Philadelphia	2	84	142,046
Total	14	429	825,560

Cotton receipts at Savannah, 1901.

Number of bales	1,082,822

Receipts of naval stores at the port of Savannah, season of 1901-2.

Spirits of turpentine	casks	314,346
Rosin	barrels	1,071,440

Arrivals and clearances of vessels and commerce at Savannah, Ga., from January 1 to December 31, 1901.

	Coastwise.			Foreign ports.						Total.			Greatest draft.
				American vessels.			Foreign vessels.						
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	
													Feet.
Arrived.	513	850,877	18,509	21	12,084	254	249	277,380	4,369	774	1,140,341	23,132	23.25
Cleared.	461	756,387	17,172	7	2,574	63	284	368,553	5,641	752	1,127,514	22,876	24.33

Commerce (foreign).

Value of exports	$44,166,293.00
Value of imports	781,818.00
Duties collected	43,487.24

O 2.

IMPROVEMENT OF SAVANNAH RIVER, GEORGIA.

At the close of the fiscal year the project depth can be carried from Savannah to Augusta, except for a shoal at Stingy Venus, on which there is slightly less than the project depth, and a bad shoal that has recently formed at Tweedy's bar, on which there is 3.4 feet of water. In the upper 18 miles of the river the banks cave very readily and, while it is comparatively easy to create the project depth, it will require considerable work to hold the river in that position, as the banks at a number of places must be thoroughly revetted.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1902.

The construction of training dikes near Augusta was continued by Albert J. Twiggs, under his contract of November 9, 1900, until August 7, 1901, when the contract was completed. Work was carried on at Twiggs bar, Blue House bar, and Gardiners bar. There were placed during the fiscal year, under this contract, 23,435 linear feet of piling, 17,007 feet B. M. of waling pieces and cross-ties, 1,664 pounds of wire spikes, 10,414 cubic yards of brush bundles, and 2,024 cubic yards of stone.

The construction of additional training dikes and shore protection dikes near Augusta was begun August 8, 1901, under contract with Hunter & Frey dated June 25, 1901. Under this contract the following work has been done during the fiscal year:

At Gardiners bar, the training dike, begun last year under contract with A. J. Twiggs, was completed, except nailing on 199 cross-ties at the lower end. The dike is 9,534 feet long.

At Kirks bar all the piling for a dike 6,975 feet long have been driven and about three-fourths of the brush and rock filled in.

At Sand Bar Ferry the piling for a dike 1,784 feet long were driven.

At Rifle cut, training dike 2,187 feet in length, begun last year under contract with A. J. Twiggs, was completed except the placing of about 150 cubic yards of rock and 500 cubic yards of brush and the nailing on of cross-ties.

At Twiggs bar a shore protection dike 1,825 feet long, begun last year under contract with A. J. Twiggs, was completed. This dike was badly damaged by freshets and had to be practically rebuilt.

At Blue House bar the piling were driven for a shore-protection dike 1,105 feet in length. At this place eight spur dikes were completed, their total length being 845 feet. These dikes were built from the South Carolina shore to the shore-protection dike previously built under contract with A. J. Twiggs.

In this work the following quantities of materials were used: One hundred and forty thousand two hundred and ninety-seven linear feet of piling, 37,113 feet B. M. of waling pieces and cross-ties, 3,379 pounds of wire spikes, 44,896 cubic yards of brush (of which 1,751 yards were woven into mattresses), and 10,781 cubic yards of stone.

A house boat, begun last year, for use of bank parties in cutting overhanging trees, was completed. The construction of a snag boat was begun and at the close of the fiscal year was nearly completed.

Three hundred and thirty-seven snags and 55 stumps were removed from the channel, 2,813 overhanging trees and saplings and 73 logs cut on the banks, and 268 trees on banks girdled.

COMMERCE AND NAVIGATION.

A detailed statement of the sources of the commerce of this river is given on page 1331 of the Annual Report of the Chief of Engineers for 1890, and on page 1504 of the same report for 1897.

During the calendar year 1901 there were five steamers engaged in the river traffic, making 194 round trips between Savannah and Augusta, and carrying 54,600 tons of freight, valued at $3,520,000.

There were also received at Savannah from this river, in small boats and lighters, 114,411 bushels of rice, valued at $114,411. The increase in tonnage over the year previous was 8,800 tons.

During the same year 12,000,000 feet B. M. of timber was rafted down the river, valued at about $156,000.

Money statement.

July 1, 1901, balance unexpended	$146,082.52
Amount appropriated by sundry civil act approved June 28, 1902	86,000.00
	232,082.52
June 30, 1902, amount expended during fiscal year	100,635.60
July 1, 1902, balance unexpended	131,446.92
July 1, 1902, outstanding liabilities	16,194.03
July 1, 1902, balance available	115,252.89
July 1, 1902, amount covered by uncompleted contracts	29,252.89
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	10,000.00

AMOUNT AND DATE OF ALL APPROPRIATIONS.

Under the original project for improvement of the Savannah River, adopted in 1880, the following appropriations were made:

By act of Congress of—	
March 3, 1881	$15,000.00
August 2, 1882	25,000.00
July 5, 1884	15,000.00
August 5, 1886	15,000.00
August 11, 1888	21,000.00
	91,000.00
Unexpended balance from last appropriation, carried to new project	19.91
Total	90,980.09
Received from other appropriations for use of snag boat	2,500.00
Aggregate	93,480.09

Since the existing project for improving the Savannah River was adopted the following appropriations have been made for this work:

By act of Congress of—	
August 11, 1888 (balance unexpended)	$19.91
September 19, 1890	25,000.00
July 13, 1892	35,000.00
August 18, 1894	15,000.00
June 3, 1896	15,000.00
March 3, 1899	20,000.00
June 6, 1900	64,000.00
March 3, 1901	100,000.00
June 28, 1902	86,000.00
Total	360,019.91

CONTRACTS IN FORCE.

Name and address of contractor.	Character of work.	Piling (per linear foot).	Pile driving (per linear foot).	Waling pieces and cross-ties (per M feet).	Wire spikes (per pound).	Iron wire (per pound).	Brush bundles (per cubic yard).	Mattress weaving (per cubic yard).	Riprap stone (per cubic yard).	Date of approval.	Work begun.
		Cts.	*Cts.*		*Cts.*	*Cts.*	*Cts.*	*Cts.*			
Albert J. Twiggs, Augusta, Ga.[a]	Training dikes.	4	4	$25.00	6	.....	40	.....	$2.00	Nov. 22, 1900	Dec. 3, 1900
Hunter & Frey, Memphis, Tenn.	....do....	4½	8	24.00	5	5	48	75	2.10	July 10, 1901	Aug. 8, 1901

[a] Completed August 7, 1901.

Contract with Albert J. Twiggs expires 20 months after date of commencement of work.
Contract with Hunter & Frey expires within 16 months from date of commencement of work.

O 3.

IMPROVEMENT OF SAVANNAH RIVER ABOVE AUGUSTA, GEORGIA.

The Savannah River above the city of Augusta is navigable only by pole boats.

No work was done during the fiscal year ending June 30, 1902.

So far as is known no change has taken place in the condition of the improvement during the fiscal year.

COMMERCE AND NAVIGATION.

A detailed statement of the commerce tributary to this river is given in a report on the examination and survey of the river, printed as House Ex. Doc. No. 213, Fifty-first Congress, first session.

The freight carried on the river consists of cotton, grain, fertilizers, and general merchandise. In 1901 it amounted to about 2,120 tons, valued at $146,450.

Money statement.

July 1, 1901, balance unexpended	$64.45
July 1, 1902, balance unexpended	64.45
Amount (estimated) required for completion of existing project	13,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	3,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

AMOUNT AND DATE OF ALL APPROPRIATIONS.

Under the original project of improvement of Savannah River above Augusta, adopted in 1879, the following appropriations were made:

By act of Congress of—	
June 14, 1880	$16,000
March 3, 1881	8,000
August 2, 1882	15,000
Total	39,000

Since the existing project for improving this portion of Savannah River was adopted the following appropriations have been made for this work.

By act of Congress of—	
July 13, 1892	$10,000
August 18, 1894	6,000
June 3, 1896	3,000
March 3, 1899	1,000
Total	20,000

O 4.

IMPROVEMENT OF DARIEN HARBOR, GEORGIA.

Darien Harbor is constituted by that portion of Darien River between the town of Darien and Doboy Sound. Doboy Bar is essentially a portion of the harbor.

* * * The contraction works were built in the years 1893 and 1895, repaired in 1895, but apparently have never had much effect upon the channel depths, which are mostly obtained and maintained by dredging.

No work was done during the fiscal year ending June 30, 1902.

COMMERCE AND NAVIGATION.

The commerce of Darien consists almost entirely of timber. A small product of rice and naval stores is shipped from that point. A daily steamer runs to Brunswick.

In 1901 the tonnage of this port amounted to 118,834 tons, valued at $781,080.

By act of Congress approved June 13, 1902, this work was consolidated with Doboy Bar, Georgia.

Money statement.

July 1, 1901, balance unexpended	$10.46
July 1, 1902, balance unexpended for harbor at Darien and Doboy Bar	10.46

AMOUNT AND DATE OF ALL APPROPRIATIONS.

The first appropriation, $8,000 (which was expended in dredging), was made by act of Congress of June 18, 1878.

Under the existing project of improvement the following appropriations have been made for this work:

By act of Congress of—	
September 19, 1890	$25,000
July 13, 1892	25,000
August 18, 1894	25,000
June 3, 1896	20,000
March 3, 1899	10,000
Total	105,000
Grand total	113,000

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels at Darien, Ga., from January 1 to December 31, 1901.

	Coastwise.			Foreign ports.						Total.			Greatest draft.
				American vessels.			Foreign vessels.						
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	
Arrived	42	19,386	330	3	934	19	70	62,297	1,035	115	82,617	1,384	....
Cleared	42	17,543	306	....	....	....	83	75,808	1,259	125	93,351	1,565	....

Timber shipments from port of Darien, Ga.

Year.	Foreign.		Coastwise.		Total.	
	Superficial feet.	Value.	Superficial feet.	Value.	Superficial feet.	Value.
Jan. 1 to Dec. 31, 1901	58,483,772	$681,049	12,503,919	$100,031	70,987,691	$781,080

Commerce.

Value of exports	$781,080
Total collections	4,011

O 5.

IMPROVEMENT OF DOBOY BAR, GEORGIA.

This bar constitutes the nearest ocean entrance to the town of Darien and the Altamaha River. The project of improvement is to give 24 feet at mean high water by dredging.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1902.

The contract for the improvement of this bar, made with Rittenhouse R. Moore on October 4, 1899, was annulled July 17, 1901, he having done no work since December 16, 1900.

A survey was made in December, 1901, for the purpose of ascertaining the best line for dredging operations, as the channel across the bar was subject to considerable fluctuation in position and, to some extent, in depth.

Bids were advertised for under date of February 18, 1902, to be opened March 21, 1902. No bids whatever were received.

COMMERCE AND NAVIGATION.

The bulk of the timber passing through Darien from the Altamaha River will probably cross Doboy bar when the improvement is complete. When the timber is gone, which is a matter of comparatively a few years, the commerce will probably greatly decrease.

During the calendar year 1901 12,503,910 feet of timber, valued at $100,031, crossed the bar.

By act of Congress approved June 13, 1902, this work was consolidated with Darien Harbor.

Money statement.

July 1, 1901, balance unexpended	$51,291.44
June 30, 1902, amount expended during fiscal year	425.48
July 1, 1902, balance unexpended for harbor at Darien and Doboy bar	50,865.96

AMOUNT AND DATE OF ALL APPROPRIATIONS.

The first appropriation was made by act of Congress of August 5, 1886, for improving the Altamaha River, Georgia, of which $5,795.40 was used on Doboy bar. Under the existing project of improvement an appropriation of $70,000 for this work was made by act of Congress approved March 3, 1899.

Contract in force.

Contractor: Rittenhouse R. Moore, Mobile, Ala.
Character of work: Dredging.
Date of approval: October 4, 1899.
Work begun: April 9, 1900.
Expired: July 14, 1901.
Date of beginning and completing work changed by supplemental contract to April 1, 1900, and February 1, 1901, respectively.
Contract annulled July 17, 1901.

COMMERCIAL STATISTICS.

For commercial statistics see report on Darien Harbor, Georgia.

O 6.

IMPROVEMENT OF ALTAMAHA RIVER, GEORGIA.

This river is formed by the junction of the Oconee and Ocmulgee rivers. Its traffic reaches the ocean at Darien and Brunswick by way of Sapelo, Doboy, and St. Simons sounds.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1902.

The training dike at Griners Bar was completed November 13, 1901, 1 piling being driven, 854 piling sawed off, 4,147 bundles of brush and 87½ cubic yards of rock placed, and 808 waling pieces bolted on.

Six piling were driven at the upper end of the cut-off at Beards Bluff and the cut cleared of obstructions. A small quantity of rock was removed from Hell shoal.

On June 30, 1902, the depth on Coupers Bar was about 1 foot at low water. The old improvements at Beards Bluff and Marrowbone Bar are not in good condition and the river has shoaled at these points—at Beards Bluff in particular. There are several other points on the river that need work and there are many snags to be removed.

COMMERCE AND NAVIGATION.

The principle items of commerce of the river are timber and naval stores and the merchandise necessary to supply the camps of the producers of those articles.

During the calendar year 1901, 114,109,000 feet B. M. of timber were rafted down the river, valued at about $1,428,000. The majority of this timber came from the Oconee and Ocmulgee rivers and was rafted down the Altamaha to mills at Darien and vicinity. Twenty-seven million two hundred and twenty-one thousand four hundred and fifty-five feet, valued at about $351,000, originated on the Altamaha.

There were also handled about 15,000 tons of freight, valued at about $1,025,000.

One steamer plies the river between Doctortown and the Forks, making two round trips per week, and another from Hollingsworth Ferry, on the Ocmulgee River, to Brunswick, making three round trips per month.

Money statement.

July 1, 1901, balance unexpended		$1,873.07
Amount appropriated by river and harbor act approved June 13, 1902		10,000.00
		11,873.07
June 30, 1902, amount expended during fiscal year		1,654.76
July 1, 1902, balance unexpended		10,218.31
Amount (estimated) required for completion of existing project		98,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$30,000.00	
For maintenance of improvement	8,000.00	
		38,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

AMOUNT AND DATE OF ALL APPROPRIATIONS.

Under the original project of improvement of the Altamaha River, adopted in 1880, the following appropriations were made:

By act of Congress of—	
March 3, 1881	$5,000.00
August 2, 1882	15,000.00
July 5, 1884	20,000.00
August 5, 1886	20,000.00
August 11, 1888	10,000.00
	70,000.00
Unexpended balance of last appropropriation carried to new project	223.41
Total	69,776.59

Since the existing project for improving Altamaha River was adopted in 1890 the following appropriations have been made for this work:

By act of Congress of—	
August 11, 1888 (unexpended balance)	$223.41
September 19, 1890	15,000.00
July 13, 1892	15,000.00
August 18, 1894	10,000.00
June 3, 1896	10,000.00
March 3, 1899	6,000.00
June 6, 1900 (allotted from emergency appropriation)	9,000.00
June 13, 1902	10,000.00
Total	75,223.41
Grand total	145,000.00

O 7.

IMPROVEMENT OF OCONEE RIVER, GEORGIA.

This river is a tributary to the Altamaha River, and the project for its improvement contemplates the same depth, viz, 3 feet at summer low water.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1902.

The training dike at Bonny Clabber Cut-Off, begun last year, was completed August 17, 1901. Forty-four piling were driven and sawed off and 1,153 bundles of brush and 16 cubic yards of rock placed in the work.

Six snags and 4 overhanging trees were removed and the cut through Fish Trap Dam was widened.

On June 30, 1902, the river was in bad condition, as the snags have never been thoroughly removed. Rock ledges above Dublin require removal, and the 5 miles just below the head of navigation at Milledgeville is shoal for great distances and will require considerable work to improve it.

COMMERCE AND NAVIGATION.

The Oconee River is navigable from the mouth to Milledgeville. During the year 1901 the steamers plying the river in the vicinity of

Dublin handled 32,000 tons of freight, valued at $480,000. In addition to this there were rafted down the river during the same year 55,704,500 feet B. M. of timber, valued at about $684,870. Excepting the timber traffic, the commerce of the river is carried on in detached segments tributary to the railroads crossing the river.

Money statement.

July 1, 1901, balance unexpended		$662.42
Amount allotted July 18, 1901		650.00
Amount appropriated by river and harbor act approved June 13, 1902		25,000.00
		26,312.42
June 30, 1902, amount expended during fiscal year		1,219.15
July 1, 1902, balance unexpended		25,093.27
Amount (estimated) required for completion of existing project		110,900.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$30,000.00	
For maintenance of improvement	8,000.00	
		38,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

AMOUNT AND DATE OF ALL APPROPRIATIONS.

Since the works of improvement were begun the following appropriations have been made:

By act of Congress of—	
June 18, 1878	$10,000.00
March 3, 1879	1,500.00
June 14, 1880	1,500.00
March 3, 1881	2,500.00
August 2, 1882	5,000.00
July 5, 1884	3,000.00
August 5, 1886	9,000.00
August 11, 1888	12,500.00
Total	45,000.00
Unexpended balance from last appropriation carried to new project	201.18
Total	44,798.82

Since the existing project for improving the Oconee River was adopted the following appropriations have been made for this work:

By act of Congress of—	
August 11 1888 (unexpended balance)	$201.18
September 19, 1890	25,000.00
July 13, 1892	25,000.00
August 18, 1894	10,000.00
June 3, 1896	10,000.00
March 3, 1899	10,000.00
June 6, 1900 (allotted from emergency appropriation)	3,100.00
June 13, 1902	25,000.00
Total	108,301.18
Grand total	153,100.00

O 8.

IMPROVEMENT OF OCMULGEE RIVER, GEORGIA.

The head of navigation of this river is Macon, but the river during recent years has not been navigated above Hawkinsville, owing to heavy rock shoals just above that place and the existence of continuous sand bars for several miles just below Macon. Between those two obstructions the river has ample depth, but is quite narrow and crooked, with numerous snags, which have never been thoroughly cleaned out.

The project for the improvement of this river is for 3 feet at summer low water, the same as the Altamaha River.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1902.

Work was continued on this river throughout the fiscal year.

The following training dikes for the removal of sand bars were completed: Four at Macon, 1,060 feet, 2,875 feet, 482 feet, and 1,951 feet long, respectively; three at Mansfields Bar, 840 feet, 552 feet, and 540 feet long, respectively, the latter being driven for a shore protection; another at Davis Reach, 1,950 feet long; another at Mitchells Bar, 350 feet long; and another at Hollingsworth Ferry, 1,350 feet long.

In the construction of these dikes during the fiscal year there were 500 piling driven, 3,715 sawed off, and 3,704 bolted; 18,302 bundles of brush and 1,011 cubic yards of rock placed, and 532 cubic yards of rock quarried.

The cut-offs at Gees Point and Cow Face Bar were widened and the cut-off at House Creek Suck, just above Hollingsworth Ferry, was opened. In this work 299 snags, 683 stumps, 434 logs, and a quantity of earth were removed; 735 trees cut on the bank, and the cuts cleared of brush. Cut-offs were also opened at Tobesofkee, Wild Cat Point, Deanes Whirl (2), and near Tobesofkee, for the purpose of straightening the river.

Work was begun toward the removal of the rock shoals above Hawkinsville. A channel about 50 feet wide was cut completely through Buttermilk shoals, in which work 3,074 cubic yards of rock were removed. A cut through Town shoals was about one-half completed, 545 cubic yards of rock being removed.

The snag boat *Satilla* began operations about 50 miles from the mouth, the river below that point having been thoroughly cleaned. Work was carried on for a distance of about 43 miles, bringing it to within about 3 miles of Abbeville. During the high water of the winter the boat worked in the upper part of the river, completing the removal of the snags between Macon and Bullards, about 30 miles. During the year 2,865 snags and 514 stumps were removed, and 259 logs and 21,967 overhanging trees and saplings cut on the banks.

A house boat, for use of bank parties in cutting overhanging trees, begun last year, was completed.

During March, 1902, an unusually destructive flood damaged the banks of the river for long distances above and below Macon. This cut around the head of one of the training dikes, diverting the river and filling the channel with sand. Work of repair was begun in June, 1902.

At the close of the fiscal year the navigable depth of the project appears to be obtained between the mouth and Hawkinsville, 133 miles.

The river is in first-class condition in all respects between the mouth and a point 3 miles below Abbeville, a distance of 93 miles, from which point to Bullards Bar, a distance of 79 miles, the river is full of snags. The navigable depth between Hawkinsville and Macon is apparently obtained at all points except on the rock shoals just above Hawkinsville and on the temporary bar just below Macon.

COMMERCE AND NAVIGATION.

A detailed discussion of this subject will be found on pages 1478 to 1484 of the Report of the Chief of Engineers for 1890, and page 1520 of the same report for 1897.

At present there is no navigation at all between Macon and Hawkinsville, except that one small steamer occasionally goes to Macon.

Three steamers are engaged in the river traffic, running as follows: One between Hawkinsville and Wilcox Lake, making two round trips per week; one between Lumber City and Wilcox Lake, making two round trips per week, and one between Hollingsworth Ferry and Brunswick, making three round trips per month.

During the calendar year 1901 there were handled by these boats 15,000 tons of freight, valued at about $1,000,000. There were also rafted down the river 40,500,000 feet B. M. of timber, valued at about $525,000.

Money statement.

July 1, 1901, balance unexpended	$47,228.07
Amount appropriated by sundry civil act approved June 28, 1902	56,000.00
	103,228.07
June 30, 1902, amount expended during fiscal year	47,217.34
July 1, 1902, balance unexpended	56,010.73
July 1, 1902, outstanding liabilities	10.73
July 1, 1902, balance available	56,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	8,000.00

AMOUNT AND DATE OF ALL APPROPRIATIONS.

Upon the original project of improvement of the Ocmulgee River, adopted in 1876, the following appropriations were made:

By act of Congress of—	
August 14, 1876	$15,000.0
June 18, 1878	15,000.0
March 3, 1879	7,000.0
June 14, 1880	7,000.0
March 3, 1881	5,000.0
August 2, 1882	5,000.0
July 5, 1884	3,000.0
August 5, 1886	7,500.0
August 11, 1888	15,000.0
Total	79,500.0
Unexpired balance carried forward from last appropriation to new project	224.9
Total	79,275.

Since the existing project for improving Ocmulgee River was adopted the following appropriations have been made for the work:

By act of Congress of—	
August 11, 1888 (unexpended balance)	$224.95
September 19, 1890	30,000.00
July 13, 1892	25,000.00
August 18, 1894	10,000.00
June 3, 1896	10,000.00
March 3, 1899	20,000.00
June 6, 1900	40,000.00
March 3, 1901	40,000.00
June 28, 1902	56,000.00
Total	231,224.95
Total, all appropriations	310,500.00

O 9.

IMPROVEMENT OF BRUNSWICK HARBOR, GEORGIA.

Appropriations for this improvement under the Engineer Department have heretofore been made for the removal of a shoal in East River, opposite the lower part of the city.

The act of Congress approved June 13, 1902, provides also for the improvement of the bar, which work has heretofore been carried on by direct contract between Congress and a private individual.

The project in force up to June 13, 1902, for the improvement of the inner harbor provided for a depth on the shoal in East River of 15 feet at mean low water. The act of Congress approved June 13, 1902, adopts a project calling for 21 feet at mean low water on this shoal.

During the fiscal year ending June 30, 1902, four piling were driven to mark the training wall.

The jetties are unchanged from last year. The controlling depth on the shoal in East River at the close of the fiscal year was 16 feet at mean low water.

COMMERCE AND NAVIGATION.

Information in regard to the commerce of Brunswick before the improvement will be found on page 1523 of the Report of the Chief of Engineers for 1897. Since 1880 the annual tonnage of the port and its value have grown very much, the shipments of cotton, for instance, having increased from 4,000 bales in 1885 to 200,541 in 1897.

The chief articles of export are cotton, lumber, and naval stores, of which the shipments for the year 1901 were as follows: Of cotton, 173,909 bales; of lumber, 184,523,000 feet, and of naval stores, 84,158 barrels of turpentine and 281,036 barrels of rosin.

The regular lines of steamships established between this port and New York and Boston comprise a total of 10 steamers. During the year 1901 they made 106 round trips and carried 177,421 tons of freight.

On the inland waters there are a number of small steamers plying between Brunswick and adjacent ports, besides numerous schooners and small sailboats. It is estimated that for the year 1901 this portion of the commerce amounted to 6,900 tons, valued at $1,650,000.

The total tonnage of the port, inward and outward bound, coastwise and foreign, during 1901 was 677,256 tons, valued at $28,091,111.

Money statement.

July 1, 1901, balance unexpended		$247.06
Amount appropriated by river and harbor act approved June 13, 1902		165,000.00
		165,247.06
June 30, 1902, amount expended during fiscal year		64.31
July 1, 1902, balance unexpended		165,182.75
Amount (estimated) required for completion of existing project		160,700.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$160,700.00	
For maintenance of improvement	15,000.00	
		175,700.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

AMOUNT AND DATE OF ALL APPROPRIATIONS.

Since the work of improvement was begun the following appropriations have been made:

By act of Congress of—		
July 4, 1836		$10,000
March 3, 1879		20,000
June 14, 1880		10,000
March 3, 1881		5,000
August 2, 1882		25,000
July 5, 1884		10,000
August 5, 1886		22,500
August 11, 1888		35,000
September 19, 1890		35,000
July 13, 1892		27,500
Total		200,000
For maintenance:		
August 18, 1894		10,000
June 3, 1896		15,000
March 3, 1899		10,000
Aggregate		235,000
By act of Congress of June 13, 1902:		
Outer bar	$40,000	
Inner harbor	120,000	
Academy Creek	5,000	
		165,000
Total of all appropriations		400,000

COMMERCIAL STATISTICS.

Exports.

Articles.	Foreign.	Domestic (coastwise).	Articles.	Foreign.	Domestic (coastwise).
Cotton ....bales..	143,653	30,256	Hay ....tons..	7	....
Cotton-seed meal.tons..	1,424	....	Sheeting ....bales..	....	8,019
Cotton seed.......do....	2,197	....	Straw ....do....	....	1,000
Cotton-seed-oil cakes, tons	99	....	Oysters..........cases..	....	27,905
Linters..........bales..	25	1,830	Potatoes......barrels..	....	200
Cotton-seed oil.barrels..	1,200	8,005	Cocoanuts ......bags..	....	1,071
Rosin ....do....	180,028	101,008	Breadstuffs......tons..	272	....
Turpentine ......do....	55,091	29,067	Barbed wire ....coils..	400	....
Wool............bales..	....	420	Hardwood ....tons..	109	....
Fiber ....tons..	....	560	Shingles ....number..	989,650	11,551,000
Empty barrels, number..................	....	200	Ties..............do....	52,977	1,548,470
Pig iron..........tons..	4,871	1,572	Laths ....do....	5,000	343,000
Phosphates ......do....	31,884	....	Tobacco ....tons..	¼	....
Tar............barrels..	1	25	Piling ....feet..	31,000	....
Merchandise.....tons..	1	434	Lumber and timber, feet..................	39,086,000	145,437,000

Exports and imports.

	Tons.	Value.
Exports, domestic (coastwise) and foreign	609,397	$15,349,212
Imports..	60,959	11,091,899
Total..	670,356	26,441,111

Steamship lines.

Line.	Steamers.	Voyages.	Freight.
			Tons.
Mallory Steamship Line: Brunswick to New York..................	4	52	136,565
The Clyde Line: Brunswick to New York and Boston..............	6	54	40,856
Total	10	106	177,421

Arrivals and clearances of vessels and commerce at Brunswick, Ga., 1901.

	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
Arrived........	470	399,874	6,695	28	18,439	256	112	91,397	1,665	610	509,710	8,616
Cleared........	467	381,296	6,539	19	9,298	160	137	120,620	2,070	623	511,214	8,769

COMMERCE (COASTWISE AND FOREIGN), 1901.

Value of **exports**..	$15,349,212.00
Value of **imports**..	11,091,899.00
Total collection..	8,106.79

Statement of receipts of naval stores, 1901.

Rosin..barrels..	242,522
Spirits..do....	72,341

O 10.

IMPROVEMENT OF THE INSIDE WATER ROUTE BETWEEN SAVANNAH, GEORGIA, AND FERNANDINA, FLORIDA.

The description of this route will be found in the report of the Chief of Engineers for 1900, page 1953, and the waters forming it are also shown on Coast-Survey Charts Nos. 156 and 157.

The project of improvement calls for a mean low water depth of 7 feet between Savannah and Fernandina.

During the fiscal year ending June 30, 1902, three piling were driven to mark the training wall in Jekyl Creek.

COMMERCE AND NAVIGATION.

A detailed discussion of the commerce over this route will be found in the Report of the Chief of Engineers for 1901, page 1653.

For the calendar year 1901 the commerce over this route amounted to 42,176 tons of freight, valued at about $2,614,955, besides 163,362,478 feet B. M. of timber, valued at about $1,668,164. There were carried by the boats over this route 64,217 passengers, principally between Brunswick and Cumberland and St. Simons Islands, Georgia, Fernandina, Fla., and Darien, Ga. None of this commerce went over the entire route.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended		$132.59
Amount appropriated by river and harbor act approved June 13, 1902		15,000.00
		15,132.59
June 30, 1902, amount expended during fiscal year		48.25
July 1, 1902, balance unexpended		15,084.34
Amount (estimated) required for completion of existing project		41,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$41,000.00	
For maintenance of improvement	15,000.00	
		56,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

AMOUNT AND DATE OF ALL APPROPRIATIONS.

Previous to the existing project there were appropriated as follows:

Parsons cut or Romerly marshes, Georgia:	
Act of Congress approved—	
August 2, 1882	$10,000.00
July 5, 1884	10,000.00
August 5, 1886	17,475.00
August 11, 1888	4,633.77
Total by United States	42,108.77
From Georgia and Florida Steamboat Company	5,000.00
Total	47,108.77

Jekyl Creek, Georgia:	
Act of Congress approved—	
August 11, 1888	5,000.00
September 19, 1890	7,500.00
July 13, 1892	7,500.00
August 18, 1894	4,000.00
Total	24,000.00

Since the existing project for improving this route was adopted four appropriations, aggregating $64,000, have been made, as follows:

Inside route:	
Act of Congress approved—	
July 13, 1892	$15,000.00
August 18, 1894	20,000.00
June 3, 1896	14,000.00
June 13, 1902	15,000.00
	64,000.00
Making a total of	135,108.77

O II.

IMPROVEMENT OF CUMBERLAND SOUND, GEORGIA AND FLORIDA.

The entrance to Cumberland Sound is situated between Cumberland Island, Georgia, and Amelia Island, Florida. The principal port is Fernandina, in the State of Florida.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1902.

Jetty work was continued throughout the fiscal year by Christie, Lowe & Heyworth, under their contract. During the year 139,277.35 tons of large stone and 123,386.24 tons of small stone were placed, making a total to date of 192,430.97 tons of large stone and 192,955.67 tons of small stone placed under this contract.

The order by which the work was carried out was with a view to causing the incipient north channel, between the jetties, to open, and at the same time allow the large sand bar between the jetties to be carried seaward by the ebb tide and to the southward over the unobstructed line of the south jetty by the action of currents and winds from the northeast. By this means the north channel increased in depth until on May 20, 1902, it had a greater depth than the temporary channel across the south jetty and the buoys were removed to the new channel on May 28, 1902, since which date it has been entirely used by shipping, and the closing of the gap in the south jetty is well under way.

The Government dredge *Winyah Bay* was employed from March 31, 1902, to the close of the fiscal year to insure against temporary shoaling at any part of the new channel. Previous to the change of buoys she removed 72,811 cubic yards of material from the channel, which amount has since that date been increased to 114,083 cubic yards.

The contract of September 25, 1900, with C. P. Goodyear, for dredging in the temporary channel, which was to have been completed July 1, 1901, was further extended to September 1, 1901. The contract was completed August 31, 1901. During the fiscal year 32,960.32 cubic yards of material were removed, making a total of 47,292.39 cubic yards removed under this contract.

The condition of the jetty work on June 30, 1902, is as shown on the small map herewith.

Jetty work is going on very rapidly, the effective longitudinal jetty section constructed during the fiscal year being 128,800 square feet. There had been 137,011 square feet constructed between 1880 and 1897 and 63,900 square feet in 1900 and 1901, making a total of 329,711 square feet. It is estimated that 149,200 square feet remain to be constructed to complete the projected jetties.

The channel is deeper than it has ever been and is straight and easily navigated. The depth at mean low water is 20 feet on the bar and 19 feet on a shoal inside, with prospects for considerable increase in the near future, as the work goes on.

The new dredge is expected to be ready for operations about October 1, 1902.

COMMERCE AND NAVIGATION.

Neglecting the commerce of St. Marys, Ga., the total commerce of the harbor of Fernandina during the calendar year 1901 amounted to 479,337 tons, with a value of $15,212,339. The details of its history are given in the tables appended hereto.

Money statement.

July 1, 1901, balance unexpended	$833, 237. 81
Amount appropriated by sundry civil act approved June 28, 1902	400, 000. 00
	1, 233, 237. 81
June 30, 1902, amount expended during fiscal year	587, 169. 14
July 1, 1902, balance unexpended	646, 068. 67
July 1, 1902, outstanding liabilities	62, 248. 75
July 1, 1902, balance available	583, 819. 92
July 1, 1902, amount covered by uncompleted contracts	412, 498. 37
Amount (estimated) required for completion of existing project	495, 000. 00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	400, 000, 00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

AMOUNT AND DATE OF ALL APPROPRIATIONS.

Under the original project for improving Cumberland Sound the following appropriations were made for the work:

By act of Congress of—	
June 14, 1880	$30, 000
March 3, 1881	100, 000
August 2, 1882	50, 000
July 5, 1884	75, 000
August 5, 1886	112, 500
August 11, 1888	112, 500
Total	480, 000

Under the revised project of improvement the following appropriations were made:

By act of Congress of—

September 19, 1890	$112,500
July 13, 1892	170,000
August 17, 1894	170,000
Total	452,500

Under the existing project of improvement the following appropriations have been made:

By act of Congress of—

June 3, 1896	$5,000
June 4, 1897	350,000
July 19, 1897	50,000
July 1, 1898	450,000
March 3, 1899	400,000
March 3, 1901	200,000
June 28, 1902	400,000
Total	1,855,000

CONTRACTS IN FORCE.

Name and address of contractor.	Character of work.	Rate.	Date of approval.	Work begun.	Expires.
		Cents.			
C. P. Goodyear, Brunswick, Ga.[a]	Dredging	16	Oct. 27, 1900	Nov. 1, 1900	Within 90 days from commencement of work.[b]

[a] Completed August 31, 1901.

[b] Extended to September 1, 1901.

Name and address of contractor.	Character of work.	First-class stone (per ton).	Second-class stone (per ton).	Third-class stone (per ton).	Mattresses (per square yard).	Date of approval.	Work begun.	Expires.
					Cents			
Christie, Lowe & Heyworth, Chicago, Ill.	Jetty	$2.15	$2.15	$1.90	70	Aug. 30, 1900	Nov. 1, 1900	Within 4 years from commencement of work, subject to the provisions of paragraph 53 of the specifications.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels and commerce at Fernandina, Fla., 1901.

	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
Arrived	235	150,753	2,772	34	19,732	278	50	56,027	908	319	226,512	3,369
Cleared	192	129,998	1,786	29	16,426	228	89	97,486	794	310	243,910	2,708

COMMERCE

Value of exports:	
Foreign	$2,558,840.00
Coastwise	11,434,256.00
Value of imports:	
Foreign	49,953.00
Coastwise	14,790.00
Total commerce	14,057,839.00
Duties collected	1,576.83

O 12.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

On May 10, 1901, the Chief of Engineers, by authority of the Secretary of War, allotted $100 for the removal of the wreck of the river steamer *Pete Craig*, sunk in Savannah River, Georgia, near Twiggs bar. Owing to continued high water the wreck was not removed until October 31, 1901. The cost of the work was $35.63, and the unexpended balance of $64.37 was returned to the Treasurer of the United States on November 3, 1901.

APPENDIX P.

IMPROVEMENT OF RIVERS AND HARBORS ON THE EASTERN COAST OF FLORIDA, AND OF HARBOR AT KEY WEST, FLORIDA, AND ENTRANCE THERETO.

REPORT OF CAPT. HERBERT DEAKYNE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. **St. Johns River, Florida.**
2. **St. Johns River at Orange Mills Flats, Florida.**
3. **Volusia Bar, Florida.**
4. **Oklawaha River, Florida.**
5. **St. Augustine Harbor, Florida.**
6. **Indian River, Florida.**
7. **Biscayne Bay, Florida.**
8. **Harbor at Key West, Florida, and entrance thereto.**
9. Removing the water hyacinth from Florida waters.
10. Dredge for river and harbor improvements, Florida.
11. Removing sunken vessels or craft obstructing or endangering navigation.

United States Engineer Office,
Tampa, Fla., July 18, 1902.

General: I have the honor to submit herewith the following reports of river and harbor works in my charge for the fiscal year ending June 30, 1902.

Very respectfully, your obedient servant,

Herbert Deakyne,
Captain, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

P 1.

IMPROVEMENT OF ST. JOHNS RIVER, FLORIDA.

For a description of this locality, the requirements of commerce, the project adopted and its modifications, the methods used, the work accomplished, its cost, and the results obtained, attention is invited to pages 1305 to 1312, Annual Report of the Chief of Engineers for 1896, and to pages 1586 to 1604, Annual Report of the Chief of Engineers for 1895, the latter being a report upon a survey of St. Johns River, Florida, from Jacksonville to the ocean, with a view of securing a 24-foot channel, and to pages 1327 to 1330, Annual Report of the Chief of Engineers for 1898.

Work under the contract with Roderick G. Ross, of Jacksonville, Fla., for work on the north jetty at the entrance, began March 2, 1900, and was completed August 15, 1901. Under this contract 48,361.6 tons of first-class stone, 19,753.1 tons of second-class stone, and 16,313.8 tons of third-class stone were placed in the north jetty. This work resulted in raising the north jetty to 7 feet above mean low water from station 3500 to station 8669, and to 3 feet above mean low water from station 8669 to station 9408, and to from 3 to 7 feet above mean low water from station 9408 to station 9738, and in extending the foundation to station 13000. That portion of the extension of the jetty beyond station 10934 was built up to from 1 to 7 feet below mean low water.

The channel across the bar at the entrance to the river having shoaled to such an extent that vessels could not take their customary cargo, the U. S. dredge *Winyah Bay* was secured and began dredging at that place November 29, 1901. A survey made November 29 showed that the channel across the bar had an available depth of less than 10 feet at mean low water. The dredge worked until March 21, and left for Charleston on March 24, 1902. A total of 48,915 cubic yards was removed from the channel across the bar at the entrance to the river, 26,618 cubic yards from Mile Point cut and 8,186 cubic yards from Dames Point cut. Work was done at Mile Point cut and at Dames Point cut when weather conditions prohibited work on the bar at the entrance.

The survey of the entrance to the river was made June 5 to 19, 1902. The field work of a survey for the purpose of ascertaining the character of the material and for obtaining a profile and the adjacent contours along a line crossing the peninsula back of Dames Point from Browns Creek to Dunns Creek, was begun June 18, 1902. This work was still in progress at the end of the fiscal year.

The cost of this dredging work was paid from an allotment of $10,000 made December 20, 1901, by the Secretary of War from the emergency appropriation of June 6, 1900.

The river and harbor act of June 13, 1902, contained the following item:

> Improving Saint Johns River, Florida, from Jacksonville to the ocean: Continuing improvement, three hundred and fifty thousand dollars: *Provided*, That a contract or contracts may be entered into by the Secretary of War for such materials and work as may be necessary to prosecute the approved and modified project, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate nine hundred and fifty thousand dollars, exclusive of the amounts herein and heretofore appropriated: *Provided further*, That out of said amounts one hundred and fifty thousand dollars may be expended in the construction or purchase of a sea-going suction dredge.

The map of the survey of the entrance to the river made in June and the map of the survey of the bar at the entrance made November 29, 1901, are presented herewith. A comparison of these maps and that of the survey made in April, 1901, shows very material changes in depths have been in progress during the year.

There is an available channel across the bar at the present time having a least depth of 16 feet at mean low water. There are three other channels across this shoal, to the northward of the main channel, having least depths in excess of 13 feet at mean low water. From near the outer end of the north jetty around the curve following the outer 15-foot contour for a distance of 2,700 feet, the inner 15-foot contour is practically parallel to the outer 15-foot contour and at an average distance of only about 350 feet from it. There is a plainly marked ridge extending from the north side of the main channel on the bar to a point about midway between the jetties abreast of station 11500 on the north jetty, having a depth of only about 15 or 16 feet over it. This appears to follow a line marking the minimum resultant of the combined effect of the ebb currents on the north side and the flood currents on the south side (bearing in mind the fairly well-established fact that the normal flood-tide current flows to the northward along this coast). It is reasonable to assume that the remarkable changes which have taken place are due to the recent work of building up and extending the north jetty.

There has been a marked accumulation of sand along the inner side of the north jetty between stations 3600 and 7600. This sand has already reached a height, in places, above the level of the water at its highest stage during the time of ordinary ebb flow, hence it is safe to assume it is not deposited during the ebb tide. It is believed that it is brought in from the outside of the jetty by overtopping sand-laden waves. It is not thought that this sand will be carried inside any appreciable distance away from the jetty.

The contours on each side of the north jetty along the low portion between the shore and station 3500 indicate the flow of a considerable volume of water across this portion of the jetty.

As noted last year, the slope of the western side of the large shoal inside of and adjacent to the north jetty continues to flatten. The apex of this shoal or middle ground is doubtless maintained in its position by the heavy waves which race up the channel between the jetties from the sea.

The crest of the north jetty has been lower in places by wave action and presents a more irregular profile than last year, but it may be considered to be in a fairly good condition.

The channel has encroached so much on the extension of this jetty, which has a foundation only 50 feet wide, that a revetment is needed along the inner side of that portion of the work.

The crest of the south jetty remains about as last year except near the outer end, where it has been lowered somewhat.

The improved condition of the bar transfers the limiting depths to the shoals in the river.

The channel above the mouth is in about the same condition as reported last year. There is an available channel depth of about 16½ feet at mean low water. Complaints have been made that the channel at White Shells, about 1 mile below St. Johns Bluff, is getting so narrow as to cause trouble there. Much complaint is made regarding the turn about Dames Point. The vessels are loaded to draw as much as the depth at this place will permit, and under the circumstances much trouble is frequently experienced in making the turn. It is reported that one of the Clyde steamships went aground five times during one trip through this place. It seems there was depth enough in midchannel for the draft the vessel had, but it could not be kept in the best water.

Money statements.

GENERAL IMPROVEMENT.

July 1, 1901, balance unexpended	$66,139.38
Amount appropriated by river and harbor act approved June 13, 1902	350,000.00
	416,139.38
June 30, 1902, amount expended during fiscal year	64,334.99
July 1, 1902, balance unexpended	351,804.39
July 1, 1902, outstanding liabilities	1,250.00
July 1, 1902, balance available	350,554.39
Amount (estimated) required for completion of existing project	1,359,750.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	200,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

EMERGENCY APPROPRIATION.

Amount allotted from emergency act approved June 6, 1900	$10,000.00
June 30, 1902, amount expended during fiscal year	9,201.74
July 1, 1902, balance unexpended	798.26

APPROPRIATIONS FOR IMPROVEMENT OF ST. JOHNS RIVER, FLORIDA.

Under the original project the following appropriations were made for the work:

June 14, 1880	$125,000	
March 3, 1881	100,000	
August 2, 1882	150,000	
July 5, 1884	150,000	
August 5, 1886	150,000	
August 11, 1888	175,000	
September 19, 1890	170,000	
July 13, 1892	112,500	
March 3, 1893	284,500	
Total		$1,417,000

Under the existing project of improvement the following appropriations have been made:

June 3, 1896	$200,000	
March 3, 1899	200,000	
June 13, 1902	[a]350,000	
		$750,000
June 6, 1900 (allotment emergency appropriation)		10,000
Aggregate		2,177,000

CONTRACT IN FORCE DURING FISCAL YEAR.

Name of contractor.	Contract.	Dated.	Approved.	Date of beginning.	Date of completion.
Roderick G. Ross	Jetty construction	Dec. 1, 1899	Dec. 30, 1899	Mar. 2, 1900	Aug. 15, 1901

Quantities.	Price per ton.
About 49,000 tons first-class stone	$2.33
About 20,000 tons second-class stone	2.33
About 20,000 tons third-class stone	2.09

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[a] And continuing contract for $950,000.

COMMERCIAL STATISTICS.

Commerce of St. Johns River, Florida, during the year ending December 31, 1901.

[Furnished by Jacksonville Board of Trade.]

Articles.	Gross tonnage.	Articles.	Gross tonnage.
Oranges	5,125	Naval stores	55,600
Cotton	16,975	Vegetables	19,911
Fertilizers	6,438	Steel rails	8,027
Fruits	13,763	Coal	73,054
Grain	10,959	Oil	2,836
Cross-ties	45,000	Tobacco	100
Shingles	15,682	Merchandise	140,000
Lumber	260,200	Iron	9,869
Kaolin	11,364		
Brick	5,276	Total	700,179

Arrivals and departures of vessels for the year ending December 31, 1901.

	Arrivals.		Departures.	
	Number.	Tons.	Number.	Tons.
Steam	241	490,583	237	491,692
Sailing	278		286	
Total	519	490,583	523	491,692

Estimated number of passengers carried by water		450,000
Estimated percentage of total trade of neighborhood carried by water		25
Probable increase of trade were the improvement completed	per cent..	100

P 2.

IMPROVEMENT OF ST. JOHNS RIVER AT ORANGE MILLS FLATS, FLORIDA.

No work has been in progress during the past fiscal year.

The sum of $50,000 could be profitably expended on this work during the fiscal year ending June 30, 1904.

Money statement.

July 1, 1901, balance unexpended	$285.53
Amount appropriated by river and harbor act approved June 13, 1902	30,000.00
	30,285.53
June 30, 1902, amount expended during fiscal year	1.15
July 1, 1902, balance unexpended	30,284.38
Amount (estimated) required for completion of existing project	50,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	50,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Act of—	
March 3, 1899	$40,000
June 13, 1902	30,000
Total	70,000

COMMERCIAL STATISTICS.

Commerce of Orange Mills Flats during the year ending December 31, 1901.

[Furnished by Wilson Cypress Company, Palatka, Fla.]

Articles.	Gross tonnage.
Fertilizers	1,000
Lumber	50,000
Shingles	3,000
Sash, doors, and blinds	3,500
Merchandise	10,000
Total	67,500

Arrivals and departures of vessels for the year ending December 31, 1901.

Sailing vessels, number of arrivals	40

P 3.

IMPROVEMENT OF VOLUSIA BAR, FLORIDA.

For a description of this locality, the requirements of commerce, the project adopted and its modifications, the methods used, the work accomplished, its cost, and the results obtained, attention is invited to the Annual Reports of the Chief of Engineers for 1897, page 1550, and for 1896, pages 1313 and 1314.

Since the appropriation of $7,500 made in the act approved August 5, 1886, the appropriations made for this improvement have been for maintenance and have been expended for that purpose.

Since July, 1899, no work has been done at this place.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902	$2,000.00
July 1, 1902, balance unexpended	2,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	4,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

Act of—		Act of—	
June 14, 1880	$5,000	July 13, 1892	$1,000
March 3, 1881	5,500	August 18, 1894	1,000
August 2, 1882	5,000	June 3, 1896	1,000
July 5, 1884	2,000	March 3, 1899	2,000
August 5, 1886	7,500	June 13, 1902	2,000
August 11, 1888	500		
September 19, 1890	500	Total	33,000

COMMERCIAL STATISTICS.

Commerce of Volusia Bar, Florida, during year ending December 31, 1901.

[Furnished by Clyde St. Johns River Line.]

Articles.	Gross tonnage.	Articles.	Gross tonnage.
Cattle	147	Pineapples	25
Fertilizers	6,102	Ship stores	692
Fruits	482	Vegetables	2,972
Grain	5,972	Fish and oysters	302
Hides	30	Tobacco	47
Honey, sirup, etc	29	Hay	3,418
Lumber	132		
Merchandise	11,244	Total	32,438
Oranges	844		

There are also other boats running independently, carrying principally naval stores and lumber, in addition to above merchandise transported by our steamers.

Arrivals and departures of vessels for the year ending December 31, 1901.

Class.	Arrivals.		Departures.	
	Number.	Tons.	Number.	Tons.
Steamers	156	31,200	156	31,200

Estimated number of passengers carried by water	31,894
Estimated percentage of total trade of neighborhood carried by water	35
Probable increase of trade were the improvement completed per cent..	150

P 4.

IMPROVEMENT OF OKLAWAHA RIVER, FLORIDA.

For description of this stream, the requirements of commerce, project adopted and its modifications, methods used, work accomplished, its cost, and the results obtained, see pages 1314 to 1316, Annual Report of the Chief of Engineers for 1896.

There were no operations on this stream during the past fiscal year.

The sum of $16,000 still remaining unappropriated of the amount originally estimated as the cost of the projected improvement of this river, in addition to $3,000 required for maintenance, could be profitably expended during the fiscal year ending June 30, 1904.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902		$2,000.00
July 1, 1901, balance unexpended		2,000.00
Amount (estimated) required for completion of existing project		16,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$16,000.00	
For maintenance of improvement	3,000.00	
		19,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

Act of—		Act of—	
September 19, 1890	$10,000	March 3, 1899	$3,000
July 13, 1892	1,000	June 13, 1902	2,000
August 18, 1894	3,000		
June 3, 1896	3,000	Total	22,000

COMMERCIAL STATISTICS.

Commerce of Oklawaha River during year ending December 31, 1901.

[Furnished by R. J. Adams, Palatka, Fla.]

Articles.	Gross tonnage.	Articles.	Gross tonnage.
Cotton	1	Merchandise	550
Fertilizers	20	Ship stores	3,500
Fruits	5	Vegetables	23
Grain	275	Hay	120
Hides	1		
Honey, sirup, etc	20	Total	4,530
Lumber	15		

REMARKS.—Millions of feet of cypress and pine logs and cross-ties are rafted by other parties.

Arrivals and departures of vessels for year ending December 31, 1901.

Class.	Arrivals		Departures.	
	Number.	Tons.	Number.	Tons.
Steamers	140	3,360	140	1,170

Estimated number of passengers carried by water 7,000

P 5.

IMPROVEMENT OF ST. AUGUSTINE HARBOR, FLORIDA

For a description of this locality, the requirements of commerce, the project adopted and its modifications, the methods used, the work accomplished, its cost, and the results obtained, see pages 1316 and 1317, Annual Report of the Chief of Engineers for 1896.

The amount appropriated by the river and harbor act of August 18, 1894, being inadequate to carry out the work designed, it has been held in reserve for emergencies that may arise as a result of storms. Considerable erosion has taken place in the vicinity of the inner two groins on the south side of the entrance.

During the autumnal storms of 1901 a considerable break in the shore line in the vicinity of groin No. 4 on Anastasia Island was made by the action of the waves. This having been brought to the attention of the Department, an examination of the prevailing conditions was made December 9, 1901. A report, with plans and estimate, was submitted, recommending the construction of a timber dam to prevent further erosion of the shore in the vicinity of groin No. 4. At this point the storms had caused a gap of about 300 feet in the shore line, allowing the tide at high water to extend about 1,000 feet farther inland than normal. The estimated cost of this work was $6,000. The recommendation was approved January 18, 1902, and work was commenced March 1, 1902.

The work consisted of a sheet-pile timber dam, thoroughly braced from the rear, 440 feet in length and parallel to the shore line, backed by a filling of marsh mud with a hearting of sand. This filling was planked over for a distance of 7 feet back from the face of the dam to protect it from the wash of overtopping waves. Four wings of timber extend seaward normal to the face of the dam for a distance of 100 feet each from about mean high water to extreme low water to serve as sand catches. It is intended to build these sand catches up, plank by plank, as the sand accumulates. The crest of the dam is 9.93 feet above the plane of mean low water. The mean rise and fall of tide is about 4½ feet.

The existing results are an increase of 4 feet in the elevation of the shore in front of the dam and an effectual stoppage of the present encroachment of the tide at this point.

This work is considered unworthy of further improvement.

Money statement.

July 1, 1901, balance unexpended	$6,000.10
June 30, 1902, amount expended during fiscal year	[a]5,071.31
July 1, 1902, balance unexpended	928.79
July 1, 1902, outstanding liabilities	155.00
July 1, 1902, balance available	773.79
Amount (estimated) required for completion of existing project	24,000.00

APPROPRIATIONS.

Act of—	
August 11, 1888	$35,000
September 19, 1890	20,000
July 13, 1892	10,000
August 18, 1894	6,000
Total	71,000

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[a] Includes $150 withdrawn for expenses of office of Chief of Engineers.

COMMERCIAL STATISTICS.

From information furnished by Thomas B. George, collector of customs, there was no water commerce at this port during the year ending December 31, 1901.

P 6.

IMPROVEMENT OF INDIAN RIVER, FLORIDA.

(1) INDIAN RIVER, BETWEEN GOAT CREEK AND JUPITER INLET.

For a description of this locality, the requirements of commerce, the project adopted, methods of improvement employed, work accomplished, and its cost, attention is invited to the Annual Report of the Chief of Engineers for 1896, pages 1318 to 1320.

There was no work done on this portion of the river during the fiscal year.

The act of June 13, 1902, appropriated $2,000 for this portion of the improvement. It having been reported that work was most needed in the river channel abreast of Santa Lucia Inlet, an artificial opening into the ocean made in 1892, an examination was made of the locality on June 18. It was found that such extensive shoaling had taken place, reducing the available channel depth to 2 feet at mean low water, that the amount available was inadequate to make even one cut through the shoal. The U. S. dredge *Suwanee* was in the vicinity at the time, but was in an unserviceable condition, principally by reason of having been at work in salt water for more than a year without being hauled out, and the teredo were making serious inroads on the hull. Accordingly it has been recommended that the expenditure of the amount available be held in abeyance until more favorable conditions obtain or additional funds are provided.

This portion of the river is of sufficient importance to warrant early completion of the projected improvement. The balance ($27,000) of the estimated cost of the improvement could be profitably expended during the fiscal year ending June 30, 1904.

(2) NEGRO CUT.

For a description of this locality, project, and work done, attention is invited to the Annual Reports of the Chief of Engineers for 1894, pages 1227 et seq., and for 1896, pages 1318 and 1319.

Work under the appropriation of $7,500 made in act of June 3, 1896, and that of $5,000 made in act of March 3, 1899, was begun by the U. S. dredge *Suwanee* June 25, 1901. Up to June 30, 1901, 1,986.9 cubic yards of material had been dredged from the channel. Work continued until January 13, 1902. The total amount of material removed from the channel with the funds provided in the two acts mentioned was 37,103.9 cubic yards, thereby forming a channel 7 feet deep and 100 feet wide for a distance of 3,000 feet and 50 feet wide for a distance of 1,300 feet, completing the channel required; 5,775 cubic yards in addition was dredged outside of the channel limits and deposited on the south training wall.

Two training walls were constructed—one on the north side, at the eastern end of the dredged channel, 560.7 feet long, and one the south side, opposite the one on the north side, 880.6 feet long. These training walls are each constructed of two rows of palmetto piles 5 feet apart, the piles in each row being spaced 4 feet apart. The space between the rows is filled with compacted mangrove brush. An outside waling strip is spiked on each row and diagonal braces are spiked to the tops of the piles. Sand was then deposited on the training walls by the dredging pump. The north wall was covered with sand up to the waling strips. The funds available did not admit of depositing all the sand intended on the south wall, but it is believed that a sufficient amount was placed to prevent scour through it, and it is hoped that it will serve the purpose designed.

A total of 276 piles and 97 cords of brush was placed in the north training wall and 466 piles and 452 cords of brush in the south training wall.

It is estimated that an appropriation of $1,000 annually, or $2,000 biennially, will be required to maintain this channel.

(3) JUPITER INLET.

For description of this locality and work done see Annual Reports of Chief of Engineers for 1897, page 1554, and 1901, page 1743.

No work was done at this place during the past fiscal year. It is believed that the inlet is still in a satisfactory condition.

The U. S. dredge *Suwanee* was under charter with the Florida Coast Line Canal and Transportation Company from February 7 to July 7, 1902, at work on the inside passage between Jupiter Inlet and Biscayne Bay. During that time the dredge removed 84,220 cubic yards of material, at a cost for operating expenses and rental of about $6,100. A portion of the repairs needed to the boat are to be defrayed by the canal company.

Money statement.

July 1, 1901, balance unexpended		$11,141.13
Amount appropriated by river harbor act approved June 13, 1902		2,000.00
		13,141.13
June 30, 1902, amount expended during fiscal year		10,790.59
July 1, 1902, balance unexpended		2,350.54
Amount (estimated) required for completion of existing project		27,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$27,000.00	
For maintenance of improvement	2,000.00	
		29,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

Act of—	
July 13, 1892 (between Goat Creek and Jupiter Inlet)	$15,000
August 18, 1894 (Negro Cut)	5,000
March 2, 1895 (Negro Cut)	15,000
February 26, 1896 (Jupiter Inlet)	500
June 3, 1896 (Negro Cut)	7,500
March 3, 1899 (Negro Cut)	5,000
June 13, 1902 (between Goat Creek and Jupiter Inlet)	2,000
Total	50,000
Allotment from emergency river and harbor appropriation of June 6, 1900 (for opening Jupiter Inlet)	1,000
Aggregate	51,000

COMMERCIAL STATISTICS.

Commerce of Indian River, Florida, during the year ending December 31, 1901.

[Furnished by Florida Coast Line Canal and Transportation Company.]

Articles.	Gross tonnage.	Articles.	Gross tonnage.
Cattle	1,500	Oranges	2,000
Fertilizers	4,000	Pineapples	8,615
Fruits	50	Vegetables	4,000
Hides	25	Fish and oysters	8,000
Honey, sirup, etc	50	Hay	200
Lumber	7,992		
Merchandise	30,161	Total	66,593

P 7.

IMPROVEMENT OF BISCAYNE BAY, FLORIDA.

Biscayne Bay was made the subject of a preliminary examination, the report upon which, dated February 18, 1895, is published in the Annual Report of the Chief of Engineers for 1895, page 1567 et seq., to which attention is invited for a general description of the locality.

Under the provisions of the act of June 3, 1896, a survey of the Cape Florida entrance to the bay and the channel leading into Miami, which had been improved by the Florida East Coast Railway Company, was made in October and November, 1896, with a view of preparing an estimate for a 12-foot channel throughout. No work was done by the United States under the project and estimate submitted. The railway company proceeded to dredge the channel, and a depth of 12 feet was secured in the bay and 11½ feet on the bar at the Cape Florida entrance through a narrow channel.

The river and harbor act of March 3, 1899, contained the following provision:

> Biscayne Bay, Florida: The Secretary of War shall appoint a Board of three engineers to examine and report upon the respective routes from Miami to the sea by Norris Cut, Bear Cut, and Cape Florida entrance, respectively, with reference to the most feasible route and the cost of providing a channel eighteen feet in depth and suitable width, with a view to ascertaining the desirability of improving the same; and to pay the expense of said Board the sum of five thousand dollars, or so much thereof as may be necessary, is hereby appropriated.

The Board of Engineers appointed by authority of the Secretary of War in accordance with the above provision of law caused surveys to be made and submitted its report April 9, 1900. This report was published in the Report of the Chief of Engineers for 1900, page 1987 et seq.

Of the several routes under consideration, the Board recommended a line crossing the bay from Miami and entering the sea at a point about 4,000 feet north of Norris Cut as being most advantageous. The cost on this line of a channel 18 feet deep and 150 feet wide on the bottom, with basin and wide entrance channel, was estimated at about $1,493,743.

The river and harbor act of June 13, 1902, contains the following item:

> Improving Biscayne Bay, Florida, with a view to obtaining a channel eighteen feet deep from the wharves at Miami to the sea by way of the northerly line of the two lines north of Norris Cut, as described in the report submitted in House Document

Numbered Six hundred and sixty-two, Fifty-sixth Congress, first session, and a basin of same depth sixteen hundred feet long and five hundred feet wide, adjacent to the wharves at Miami, fifty thousand dollars: *Provided*, That a contract or contracts may be entered into by the Secretary of War for such materials and work as may be necessary for prosecuting the project, not to exceed in the aggregate two hundred and fifty thousand dollars, exclusive of the amount herein appropriated: *Provided further*, That of the work herein contemplated The Florida East Coast Railway Company shall construct, at its own expense, the basin adjacent to the wharves at Miami as herein described, and the portion of the channel from such basin to the east side of the basin proposed in the report herein mentioned, said channel to be not less than eighty-five nor more than one hundred feet in width, as shall be determined by the Secretary of War, and said basin and channel when so constructed by the railway company shall be open to the free and unobstructed use of the public: *Provided further*, That the amounts herein appropriated and authorized shall be expended in constructing and protecting the portion of the channel extending to the sea from the terminus of the channel to be constructed by the railway company of such approximately uniform depth and of such width as will best serve the interests of navigation, and as can be constructed with the funds herein appropriated and authorized: *Provided further*, That before any part of the appropriation shall be expended the said railway company shall enter into a contract with the United States satisfactory to the Secretary of War for the performing of its part of the work, and for securing in its portion of the channel and in the said basin practicable depths at least as great as are secured in the portion of the channel to be built by the United States, and for maintaining, for a period of three years after the said eighteen-foot channel to be constructed by the Government shall have been obtained, an equal depth in the basin and the channel across the bay; and the said contract shall also provide that all craft resorting to Biscayne Bay for commercial purposes may use the wharves and warehouses thereon now owned or controlled or hereafter built on Biscayne Bay by The Florida East Coast Railway Company, its successors or assigns, for reasonable rates of compensation, and that proper facilities shall be given to all persons or corporations for the shipment of freight to or from said wharves on the railway tracks of the said company in Miami for like reasonable rates and upon just and reasonable conditions, and in case of disagreement such compensation and conditions shall be determined by the Secretary of War.

At the end of the fiscal year nothing had been done in furtherance of this project.

* * * * * * *

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902	$50,000.00
July 1, 1902, balance unexpended	50,000.00
Amount (estimated) required for completion of existing project	250,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	150,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATION.

Act of June 13, 1902	[a]$50,000

P 8.

IMPROVEMENT OF HARBOR AT KEY WEST, FLORIDA, AND ENTRANCE THERETO.

For a description of this locality, the requirements of commerce, an account of early attempts at improvement, present project, methods used, work accomplished on east jetty, and results obtained, see pages 1325–1327, Report of the Chief of Engineers for 1896. For an account of work on west jetty see page 1371, Report of the Chief of Engineers for 1898, and page 1938, Report of the Chief of Engineers for 1900.

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[a] And continuing contract for $250,000.

At the beginning of the past fiscal year the channel across the northwest bar had deteriorated so that a draft of only 10 feet at mean low water could be carried through it.

On July 2, 1900, the sum of $5,000 was allotted from the emergency appropriation for rivers and harbors, act of June 6, 1900, to be expended for dredging on the northwest bar to restore the depth of 12.5 feet. Circular proposals for doing this work were opened July 23, 1900, and an agreement was made with the Stewart Contracting Company to dredge about 10,500 cubic yards at 38 cents, work to begin within thirty days. The contractor's plant was placed in position in August, but bad weather prevented work and the plant sought a harbor until October 23, when another trial was made. Continued bad weather again interfered, and the contractor abandoned the work on December 11, 1900. New proposals were invited by circular letter and only one bid was received, which was rejected, the price being too high.

A further allotment of $5,000 from the appropriation of June 6, 1900, was made July 3, 1901. It was decided to do the work by hired labor with the dredge *Winyah Bay*, belonging to the Charleston district.

The dredge began operations on August 19, 1901, and continued at work until November 9, 1901, removing in all 97,683 cubic yards. The channel was surveyed in January, 1902, and showed a least depth of 12.4 feet at mean low water.

Money statements.

GENERAL IMPROVEMENT.

July 1, 1901, balance unexpended	$318.33
Amount appropriated by river and harbor act approved June 13, 1902	100,000.00
	100,318.33
June 30, 1902, amount expended during fiscal year	148.25
July 1, 1902, balance unexpended	100,170.08
Amount (estimated) required for completion of existing project	100,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	100,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

EMERGENCY APPROPRIATION.

July 1, 1901, balance unexpended	$4,791.37
Amount allotted from emergency act approved June 6, 1900	5,000.00
	9,791.37
June 30, 1902, amount expended during fiscal year	8,777.80
July 1, 1902, balance unexpended	1,013.57

APPROPRIATIONS.

Act of—	
August 2, 1882	$25,000
August 5, 1886 (survey)	2,500
August 11, 1888	25,000
September 19, 1890	40,000
July 13, 1892	75,000
August 18, 1894	80,000
June 3, 1896	80,000
March 3, 1899	25,000
Act of—	
Allotment from emergency river and harbor act June 6, 1900	$10,000
June 13, 1902 (rivers and harbors)	100,000
Total	462,500

COMMERCIAL STATISTICS.

Commerce of Key West, Fla., during the year ending December 31, 1901.

[Furnished by the collector of customs, Mr. George W. Allen.]

Articles.	Gross tonnage.	Articles.	Gross tonnage.
Cattle	5,500	Oranges	104
Fertilizers (including phosphates)	12,835	Tobacco	394
Grain	17		
Hay	13	Total	18,863

Number of steamboats in trade	17
Number of sailing vessels in trade	271
Number of passengers carried in 1900	8,810

P 9.

REMOVING THE WATER HYACINTH FROM FLORIDA WATERS.

For information as to previous investigations and experiments leading to the inception of the project see Appendixes P 9 and P 11, pages 1612 to 1623, Report of the Chief of Engineers for 1899, and pages 1746 to 1748, Report of the Chief of Engineers for 1901.

Money statement.

July 1, 1901, balance unexpended	$34,950.42
Amount appropriated by river and harbor act approved June 13, 1902, $50,000 for States of Florida, Texas, and Louisiana. Allotment not known.	
June 30, 1902, amount expended during fiscal year	34.81
July 1, 1902, balance unexpended	34,915.61
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement in addition to the balance unexpended July 1, 1902	50,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

Act of March 3, 1899:	
For construction of boat	$25,000
For log booms	1,000
For operating expenses	10,000
Act of June 13, 1902:	
For removal of the water hyacinth from the navigable waters of the States of Florida, Texas, and Louisiana	50,000

P 10.

DREDGE FOR RIVER AND HARBOR IMPROVEMENTS, FLORIDA.

The need for a light-draft self-propelling dredge and snag boat for operations on the harbors and streams in the State of Florida, for which small appropriations are made from time to time, and the special features required in such a boat, are set forth in the Report of the Chief of Engineers for 1901, pages 1749 and 1750.

Money statement.

July 1, 1901, balance unexpended	$31,665.68
Amount appropriated by river and harbor act approved June 13, 1902	35,000.00
July 1, 1902, balance unexpended	66,665.68

P 11.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

Removal of wreck of bark Ceres in Key West Harbor, Florida.—This vessel was wrecked on the south side of the northwest channel in Key West Harbor in March, 1901. The vessel was reported to have been built in 1876 at Rostock, Germany. Her dimensions were: Length, 143 feet; breadth, 29.8 feet; depth, 17 feet; tonnage, gross, 467; net, 389.

Public notice was given in accordance with section 19 of the river and harbor act of March 3, 1899. No effort having been made by the owners to remove the wreck, after due advertisement a contract was made December 23, 1901, with James A. Lowe, of Key West, to remove the wreck for $1,090. The work was begun February 1, 1902, and was completed March 20, 1902. The wreck was broken up and all parts were removed.

APPENDIX Q.

IMPROVEMENT OF RIVERS AND HARBORS ON THE WESTERN COAST OF FLORIDA, SOUTH OF AND INCLUDING SUWANEE RIVER.

REPORT OF CAPT. HERBERT DEAKYNE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Kissimmee River, Florida.
2. Orange River, Charlotte Harbor, and Caloosahatchee River, Florida.
3. Sarasota Bay, Florida.
4. Tampa Bay, Florida.
5. Hillsboro Bay, Florida.
6. Crystal, Manatee, Anclote, Suwanee, and Withlacoochee rivers.
7. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATION AND SURVEY.

8. Kissimmee River, Florida.

(For letter of transmittal see Appendix P.)

Q 1.

IMPROVEMENT OF KISSIMMEE RIVER, FLORIDA.

This is a new work. The project was submitted December 14, 1901, and is printed in House Doc. No. 176, Fifty-seventh Congress, first session. * * * The estimated cost is $24,220.90.

The act of June 13, 1902, appropriated $8,000 for this improvement. A detailed project for the expenditure of this amount has not yet been made.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902		$8,000.00
July 1, 1902, balance unexpended		8,000.00
Amount (estimated) required for completion of existing project		16,220.90
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$16,220.90	
For maintenance of improvement	1,000.00	
		17,220.90
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Q 2.

IMPROVEMENT OF ORANGE RIVER, CHARLOTTE HARBOR, AND CALOOSAHATCHEE RIVER, FLORIDA.

These improvements were combined under one appropriation by the following item of the river and harbor act of June 13, 1902:

> Improving Orange River, Florida, in accordance with report submitted in House Document Numbered Three hundred and eighteen, Fifty-sixth Congress, first session, Charlotte Harbor and Caloosahatchee River, Florida, from Puntarasa to Punta Gorda, in accordance with the report submitted in House Document Numbered Two hundred and eighty-six, Fifty-sixth Congress, first session, nine thousand five hundred dollars, of which so much as may be necessary may be expended between Puntarasa and Fort Thompson.

Allotments from this appropriation have not yet been made.

* * * * * * *

The improvement of Charlotte Harbor and Peace Creek, in accordance with the project adopted in 1891, was completed during the fiscal year ending June 30, 1900. No appropriation was made in the recent river and harbor bill for the maintenance of the channel and the improvement of Charlotte Harbor was combined with that of the Orange and Caloosahatchee rivers.

The improvement of the Caloosahatchee River also ceases to exist as a separate work. The act of June 13, 1902, authorizes the expenditure of such amount as may be necessary between Puntarasa and Fort Thompson, evidently for the maintenance of the existing channel.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902	$9,500.00
July 1, 1902, balance unexpended	9,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	2,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

Q 3.

IMPROVEMENT OF SARASOTA BAY, FLORIDA.

For a description of this locality, the requirements of commerce, the project adopted and its modifications, the methods used, the work accomplished, its cost, and the results obtained, attention is invited to the Annual Report of the Chief of Engineers for 1896, Part II, pages 1331 and 1332, and 1900, Part III, pages 2018 and 2019, and for 1901, pages 1753 to 1755.

* * * * * * *

No work was done during the fiscal year, no funds being available.

* * * * * * *

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902...	$5,000.00
July 1, 1902, balance unexpended	5,000.00
Amount (estimated) required for completion of existing project	32,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	32,500.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

September 19, 1890	$5,000	June 13, 1902	$5,000
July 13, 1892	2,500		
August 18, 1894	2,500	Total appropriated	22,500
June 3, 1896	2,500	Expended to June 30, 1902	17,500
March 3, 1899	5,000		
		Balance	5,000

COMMERCIAL STATISTICS.

Commerce of Sarasota Bay, Florida, for the year ending December 31, 1901.

[Compiled from information furnished by Mr. John Savarese, Tampa, Fla.]

Articles.	Gross tonnage.	Articles.	Gross tonnage.
Cattle	2,940	Other fruits	11
Fertilizers	265	Fish	1,500
Grain	560	Oysters	350
Hides	28	Tobacco	1
Honey, sirup, etc	40	Merchandise	20
Lumber	2,490	Rosin and turpentine	955
Hay	32		
Vegetables	5	Total	9,349
Oranges	152		

Steamboats in trade	2
Sailing vessels in trade	38

* * * * * * *

Q 4.

IMPROVEMENT OF TAMPA BAY, FLORIDA.

For a description of this locality, the original project and its modifications, the work accomplished, its cost, and the results obtained, attention is invited to pages 1632 and 1633, Report of the Chief of Engineers for 1899, and to pages 2022 to 2025, Part III, of the report for 1900, and pages 1756 to 1758, of the report for 1901.

The channel to be dredged is, for purposes of designation, divided into sections determined by changes of direction and intervening deep-water reaches. The sections are lettered consecutively from the Gulf to Port Tampa. Section A is on the bar. Sections B, C, and D are in the Lower Bay, E and F are at the Narrows, G and H lead from the deep basin south of old Tampa Bay to the old south cut, and sections J and K are the old south and north cuts, respectively, near Port Tampa.

During the fiscal year ending June 30, 1902, the work has been continued in accordance with the project and under the continuing contract of August 5, 1899, with the Alabama Dredging and Jetty Company. The work accomplished is shown in the following table:

Year ending June 30—	Quantities dredged, in cubic yards, in section—										Total.
	A	B	C	D	E	F	G	H	J	K	
1900					183,237.8	60,035.6			52,442.9		295,715.8
1901					59,526.1	68,404.5			38,488.8	102,152.5	268,571.9
1902	45,822.2		186,124.4		248,711.4	58,282.6			99,566.0	139,722.3	778,228.9

The work of each dredge for the year ending June 30, 1902, was as follows:

Dredge.	Sections.	Cubic yards.	Period.
Herndon	E, F, J, and K	263,508.1	July 1 to Aug. 31 and Sept. 11 to Dec. 31, 1901; Jan. 6 to Apr. 19, 1902.
Jumbo	A, C, and E	304,011.4	July 1 to 26, Aug. 23 to Nov. 9, and Nov. 14 to Dec. 17, 1901; Jan. 11 to May 3, 1902.
No. 9	A, C, E, and F	210,709.4	July 1 to Sept. 30, 1901; Oct. 15, 1901, to Jan. 6, 1902; Feb. 11 to Apr. 8, 1902, and June 9 to 30, 1902.
Total	A, C, E, F, J, and K	778,228.9	

Dredging has been done in six of the channel sections, namely, A, C, E, F, J, and K. Section C has a navigable depth of 24 feet for a width of 250 feet. Section E has a navigable depth of 20.9 feet for a width of 200 feet. Section F has been deepened considerably, but a shoal exists about midway of its length with a mean low-water depth of only 19.6 feet. Section J has a depth of 24 feet for a width of 129 feet, and Section K has a depth of 24 feet for a width of 300 feet.

The work on this contract during the past year has fallen far behind the requirements. Up to June 30, 1902, the total amount removed should have been 2,542,000 cubic yards, whereas the amount actually removed was 1,342,516.6 cubic yards.

The principal cause of delay is the dilapidated condition of the plant employed. Efforts for its betterment are now being made.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$260,774.04
Amount appropriated by sundry civil act approved June 28, 1902	86,675.00
	347,449.04
June 30, 1902, amount expended during fiscal year	96,404.85
July 1, 1902, balance unexpended	251,044.19
July 1, 1902, outstanding liabilities	14,500.00
July 1, 1902, balance available	236,544.19
July 1, 1902, amount covered by uncompleted contracts	367,206.75
Amount (estimated) required for completion of existing project	326,325.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	140,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Under previous projects.

By act of—

June 14, 1880	$10,000
March 3, 1881	10,000
August 2, 1882	20,000
July 5, 1884	20,000
August 5, 1886	10,000
August 11, 1888	25,000
September 19, 1890	25,000
July 13, 1892	10,000
Total appropriated for previous projects	130,000

Expended:

On channel from Tampa through Hillsboro River and Bay	80,000
In dredging bars at entrance of old Tampa Bay	50,000
Expended on previous projects	130,000

Under present project.

By act of—

March 3, 1899	$75,000
June 6, 1900	135,000
March 3, 1901	127,000
June 28, 1902	86,675

CONTRACT IN FORCE.

Contractors: Alabama Dredging and Jetty Company, Mobile, Ala.

Work: Dredging in Tampa Bay and on the bar at the entrance to Tampa Bay, Florida.

Date of approval: September 22, 1899.

Work began: August 3, 1899.

To be completed: Continuing contract.

COMMERCIAL STATISTICS.

Commerce of Tampa Bay, Florida, for the year ending December 31, 1901.

[Compiled from information furnished by the Plant Steamship Company.]

Articles.	Gross tonnage.	Articles.	Gross tonnage.
Cattle	3,000	Fish, game, etc	264
Fertilizer	353,730	Tobacco	1,273
Grain	124	Merchandise	13,610
Hides	1	Melons	133
Lumber	1,805	Breadstuff	431
Hay	87	Coal	18,498
Vegetables	2,782	Naval stores	16,842
Oranges	3,286		
Other fruits	637	Total	413,503

Steamboats cleared Steamships cleared	272
Number passengers carried in 1901	47,175

Q 5.

IMPROVEMENT OF HILLSBORO BAY, FLORIDA.

For a description of this locality, the original project and its modifications, the work accomplished, its cost, and the results obtained, attention is invited to pages 1635 and 1636, Report of the Chief of Engineers for 1899, and to pages 2025 to 2027, Part III, of the report for 1900, and to pages 1758 to 1760 of the report for 1901.

No work was done during the year; the expenditures made were for office expenses.

The channel depth of 12 feet at mean low water with a width of 60 feet in the bay and 80 feet in the river has maintained itself with but little impairment during the year.

The river and harbor act of June 13, 1902, contains an appropriation of $150,000 for continuing the improvement. A project was submitted June 28, 1902, for the expenditure of this amount in widening the existing 12-foot channel by dredging.

* * * * * *

Money statement.

July 1, 1901, balance unexpended		$12,361.85
Amount appropriated by river and harbor act approved June 13, 1902		150,000.00
		162,361.85
June 30, 1902, amount expended during fiscal year		3,068.98
July 1, 1902, balance unexpended		159,292.87
Amount (estimated) required for completion of existing project		25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$25,000.00	
For maintenance of improvement	2,000.00	
		27,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

A list of appropriations made for previous projects in this locality are given in the report for the improvement of Tampa Bay in the Annual Report of the Chief of Engineers for 1899, page 1634.

Under present project, by act of March 3, 1899	$125,000.00
Under present project, by act of June 13, 1902	150,000.00
	275,000.00
Total expended	115,707.13
Balance unexpended June 30, 1902	159,292.87

COMMERCIAL STATISTICS.

Commerce of Hillsboro Bay for the year ending December 31, 1901.
[Compiled from information furnished by the Tampa Board of Trade.]

Articles.	Gross tons.	Articles.	Gross tons.
Cattle	7,788	Merchandise	49,783
Grain	18,500	Other material	738
Lumber	6,657	Tobacco	917
Hay	750	Turpentine	5,165
Vegetables	13,704	Rosin	12,053
Oranges	12,175		
Fish	2,978	Total	131,208

Number of steamboats in trade	8
Number of sailing vessels in trade	57

* * * * * * *

Q 6.

IMPROVEMENT OF CRYSTAL, MANATEE, ANCLOTE, SUWANEE, AND WITHLACOOCHEE RIVERS.

These improvements were consolidated by the following item of the act of June 13, 1902:

> Improving Crystal, Manatee, Anclote, Suwanee, and Withlacoochee rivers, Florida: Continuing improvement and for maintenance, thirty-five thousand dollars, and the further sum of fifteen thousand dollars, to be used in deepening the channel from the mouth of the Withlacoochee River to the loading pool in the Gulf of Mexico, being a distance of eleven thousand seven hundred and eighty feet, to the depth of 8 feet, and to straighten said channel where the same is crooked, and for the maintenance of said channel.

Allotments for the several improvements have not yet been made from the consolidated appropriation of $35,000. At the close of the fiscal year there remained available a balance of $411.33 for the improvement of Withlacoochee River. By the terms of the act of June 13, 1902, this balance is carried to the credit of the aggregate amount appropriated for the consolidated improvements.

Crystal River.—The project was submitted January 27, 1900, and is found in the report of the Chief of Engineers for 1900, pages 2078 to 2080. * * *

No work has yet been done.

* * * * * * *

Manatee River.—For a description of this locality, the requirements of commerce, the project adopted and its modifications, the methods used, the work accomplished, its cost, and the results obtained, attention is invited to pages 1332 and 1333, Report of the Chief of Engineers for 1896, and pages 2020 and 2021, Part III, of the Report for 1900. No work has been done during the fiscal year ending July 30, 1902.

* * * * * * *

Anclote River.—For the preliminary examination of this river, its survey, the requirements of commerce, the project adopted, and its estimated cost, attention is invited to Reports of the Chief of Engineers, 1895, Part II, pages 1573–1576; 1898, Part II, pages 1361–1363; 1900, Part III, pages 2028 and 2029; and 1901, pages 1760 and 1761. No work was done during the year ending June 30, 1902.

* * * * * * *

Suwanee River.—For a description of this locality, the requirements of commerce, the project adopted and its modifications, the methods used, the work accomplished, its cost, and the results obtained, attention is invited to Reports of the Chief of Engineers, 1896, pages 1335–1336; 1898, pages 1341–1342; and 1901, pages 1762 and 1763.

No work was done during the fiscal year ending June 30, 1902. The balance remaining June 30, 1901 ($207.64) was expended during the fiscal year for office expenses and contingencies.

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Withlacoochee River.—For a description of this locality, the requirements of commerce, the project adopted and its modifications, the methods used, the work accomplished, its cost, and the results obtained, attention is invited to Report of the Chief of Engineers, 1898, pages 1340–1341 and 1363–1369.

The adopted project for the improvement of this river was practically completed on November 14, 1892.

Under plans that received the approval of the Secretary of War April 21, 1894, and subject to inspection by the district engineer officer, the Dunnellon Phosphate Company is engaged in deepening a channel from the mouth of the river to the Gulf of Mexico in order that the products of the mines may be lightered to vessels in the outer anchorage.

The company continued this work during the year and reported that up to the end of April, 1902, 161,770 cubic yards of rock and 328,064 cubic yards of sand had been excavated. A survey of this channel was made in October and November, 1901. Its length was about 11,780 feet. An average depth of about 8 feet had been reached, but the depth in places was greater and in other places less than 8 feet. The available depth was 5.9 feet at mean low water.

Range of tide is about 2 feet.

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Money statements.

CONSOLIDATED APPROPRIATION.

July 1, 1901, balance unexpended: Withlacoochee, $516.50; Suwanee, $207.64		$724.14
Amount appropriated by river and harbor act approved June 13, 1902		35,000.00
		35,724.14
June 30, 1902, amount expended during fiscal year		312.81
July 1, 1902, balance unexpended		35,411.33
Amount (estimated) required for completion of existing project		133,305.46
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$133,305.46	
For maintenance of improvement	5,000.00	
		138,305.46
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

SPECIAL ALLOTMENT FOR WITHLACOOCHEE RIVER.

Amount appropriated by river and harbor act approved June 13, 1902	$15,000.00
July 1, 1902, balance unexpended	15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	2,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

Manatee River.

August 2, 1882	$12,000
August 5, 1886	11,000
August 11, 1888	5,000
September 19, 1890	6,000
July 13, 1892	6,000
August 18, 1894	$3,000
June 3, 1896	[a] 4,000
March 3, 1899	[b] 10,000
Total	57,000

Anclote River.

March 3, 1899	$5,000

Withlacoochee River.

March 3, 1881	$7,500
July 5, 1884	3,000
August 5, 1886	3,000
August 11, 1888	5,000
September 19, 1890	5,400
August 18, 1894	$800
June 13, 1902	15,000
Total	39,700

Suwanee River.

June 14, 1880	$5,000
March 3, 1881	3,000
August 2, 1882	5,000
July 5, 1884	5,000
August 5, 1886	5,000
August 11, 1888	15,000
September 19, 1890	3,000
July 13, 1892	$3,000
August 18, 1894	3,000
June 3, 1896	3,000
March 3, 1899	5,000
Total	55,000

Crystal, Manatee, Anclote, Suwanee, and Withlacoochee rivers.

June 13, 1902	$35,000

Q 7.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

Removal of boiler of abandoned steamer Kissimmee in Hillsboro Bay, Florida.—This boiler formerly lay in shallow water near the channel on the water front of Tampa, but was accidentally pulled into the channel by a schooner that had a line made fast to it. An allotment of $100 for its removal was made September 20, 1901. Bids for the work were opened, but were all in excess of the allotment. An oral agreement was then made with the Alabama Dredging and Jetty Company to do the work. The boiler was lifted between two barges on October 16, 1901, and was deposited in 5 feet of water about 70 feet eastward of the east side of the channel in Hillsboro Bay, at a point about 6,000 feet below the Lafayette Street Bridge in Tampa.

Q 8.

EXAMINATION AND SURVEY OF KISSIMMEE RIVER, FLORIDA, ETC.

[Printed in House Doc. No. 176, Fifty-seventh Congress, first session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, December 28, 1901.

SIR: The river and harbor act approved March 3, 1899, makes provision for an examination and survey to be made of—

> Kissimmee River [Florida] and connecting lakes and canals flowing into Lake Okechobee, thence down the Caloosahatchee River to the Gulf of Mexico, with a view to improving the navigation of the channels therein—

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[a] Includes $3,000 for Terraceia Cut-off.

[b] Includes $8,000 for Terraceia Cut-off.

and I have the honor to submit the accompanying copy of report, dated August 23, 1899, by Capt. Henry Jervey, Corps of Engineers, on preliminary examination, and copy of report, dated December 14, 1901, with maps,[a] by Capt. Herbert Deakyne, Corps of Engineers, on survey of the locality.

It appearing from Captain Jervey's report on preliminary examination that improvements already made by the General Government have resulted in securing in the Caloosahatchee River from Fort Thompson to the Gulf of Mexico a depth of water sufficient for the present needs of commerce, that the waterway between Fort Bassinger (on the Kissimmee River 37.5 miles above its entrance into Lake Okechobee) and Fort Thompson is not now used for carrying trade, and that there is at present no demand for such trade between the points last mentioned, only that portion of the route which is located between the town of Kissimmee (situated at the headwaters of the Kissimmee River) and Fort Bassinger was reported as being worthy of improvement by the United States. Accordingly the local officer was directed, by authority of the Secretary of War, to make a survey of the section thus reported as worthy of improvement, and to extend said survey to the mouth of the Kissimmee River, in order that necessary data might be obtained concerning the characteristics of the entire river. Istokpoga Creek, 9.4 miles long, connecting the lake of the same name with the Kissimmee River 10.5 miles north of Bassinger, was also included in the survey.

The plan of improvement presented contemplates securing in the Kissimmee River (including the connecting canals and lakes), between Kissimmee and Fort Bassinger, and also in Istokpoga Creek, a channel width of 30 feet and depth of 3 feet at the ordinary stage of the river. To effect this object it is estimated that a certain amount of dredging work and bulkhead construction and the removal of snags and trimming of trees will be necessary, the total cost of which is estimated at $24,220.90.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. ELIHU ROOT,
Secretary of War.

PRELIMINARY EXAMINATION OF KISSIMMEE RIVER, FLORIDA, AND CONNECTING LAKES AND CANALS FLOWING INTO LAKE OKECHOBEE, THENCE DOWN THE CALOOSAHATCHEE RIVER TO THE GULF OF MEXICO.

UNITED STATES ENGINEER OFFICE,
Tampa, Fla, August 23, 1899.

GENERAL: I have the honor to present the following report upon the preliminary examination of Kissimmee River and connecting lakes and canals flowing into Lake Okechobee, thence down the Caloosahatchee River to the Gulf of Mexico, with a view to improving the navigation of the channels therein, as directed by the river and harbor act approved March 3, 1899.

The examination was made by Mr. W. H. Caldwell, assistant engineer, whose report is appended.

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[a] Not reprinted; printed in House Doc. No. 176, Fifty-seventh Congress, first session.

This is the first examination that has been made of this route above the headwaters of the Caloosahatchee, and as it flows through an extensive region not reached by regular means of transportation the examination has required considerable time and expense. The assistant engineer secured a steamer suitable to make the entire trip by water, and fortuitous rains furnished a navigable depth unusual at this season.

The water route examined is about 309 miles in length, extending south from the town of Kissimmee, Fla., through a succession of shallow lakes and canals for about 46 miles to the foot of Lake Kissimmee, thence through the Kissimmee River proper for about 145 miles to Lake Okechobee, through the latter lake to a canal leaving its southwest corner, thence through several canals and small lakes to the upper waters of the Caloosahatchee River, which continues the route to San Carlos Bay in the Gulf of Mexico.

The portions of the route at present used for navigation are from Kissimmee to Fort Bassinger on the Kissimmee River, about 40 miles above its entrance into Lake Okechobee, and from Fort Thompson, on the Upper Caloosahatchee, about 23 miles west of Lake Okechobee, to the Gulf of Mexico. The intermediate portion from Fort Bassinger to Fort Thompson is seldom navigated except by tourist parties, and during a large part of the year boats could not get through. The navigation on the upper stretch of the route enables the town of Kissimmee to serve as a supply depot for the extensive cattle interests between that point and Fort Bassinger. The freight carried downstream consists of grain, forage, lumber, and general supplies for the population along the river, all of whom are far distant from railroads. The upriver freight consists of oranges, hides, and vegetables. The cattle and hogs are not transported by river, but are driven across country to some seaport, usually Puntarasa, at the mouth of the Caloosahatchee River, where they are shipped to market.

The navigation of the Caloosahatchee River, which has already been improved by the National Government below Fort Thompson, affords an outlet for the immense crop of pineapples, oranges, lemons, and other citrus fruit raised along this river. This produce is mostly taken by steamer to Myers, thence to Punta Gorda, from which point it is shipped by rail. Great numbers of cattle and hogs are also raised in this section.

As before stated, the stretch between Fort Bassinger and Fort Thompson is not now used for carrying trade, nor is there any demand at this time for such trade, as the country is an uninhabited swamp. There are no settlements on the shores of Lake Okechobee except a few orange farms on Taylors Creek, which empties into the northern extremity of the lake. Nor does it seem probable that a through water route from Kissimmee to Puntarasa, at the mouth of the Caloosahatchee, would benefit anyone in particular nor change the present conditions. Kissimmee Valley would continue to draw supplies from the town of Kissimmee, and Caloosahatchee points would continue to trade with Myers, and through that town with regular markets. We may, therefore, eliminate from consideration in any present scheme for improvement—

1. The waterway from Fort Bassinger to Fort Thompson.
2. The Caloosahatchee River from Fort Thompson to the Gulf of Mexico, as the improvements already made have resulted in a depth sufficient for the present needs of commerce.

Our study will then be confined to the lakes, canals, and river above Fort Bassinger.

The territory tributary to this water route comprises about 2,500 square miles. It is essentially a cattle country, the mild climate, abundant pasturage, and almost unlimited ranges reducing the cost of raising to a low figure. Orange culture has reached considerable proportions also, and is on the increase. The railroads that parallel this valley on the east and west are from 30 to 50 miles distant and the cross-country roads are few and swampy, sometimes impassable. They are used only by mail riders, as all supplies are drawn from Kissimmee, being carried on wagons when low water stops navigation.

The chief obstacle to the development of this region is the frequent occurrence of long periods of extremely low water covering sometimes nearly the half the year, during which navigation is impossible and the population cut off from their usual source of supply.

The periods during which navigation has been stopped in the Kissimmee River on account of low stages of water are reported as follows:

1895	five months.
1896	none.
1897	eight months.
1898	five months.
1899	probably none.

The obstructions to navigation are chiefly sand bars. There are some snags and many obstructive bends in the river, which is very tortuous. Water hyacinth is not present to any great extent. Local attempts at improvement of the waterway have been made by dredging canals connecting the lakes near Kissimmee and by making "cut-offs" across some of the worst bends in the river. It is said that the canals have lowered the level of the lakes, but have on the whole been a benefit to navigation, providing straighter and safer channels. The cut-offs have likewise proved beneficial, and injury to the river has not been observed. The work done has been on a very small scale. The depths in the several channels at the time of this examination are given in the table appended to this report. They are seen to vary from 1.8 to 30 feet, being generally from 3 to 5 feet.

Parties interested in navigation state that a channel 36 inches deep at low water and 30 feet wide will be ample for the present commerce.

The commercial statistics gathered from several points along the entire route are given in Mr. Caldwell's report.

A summary indicates the following tonnage and value of water-borne commerce in the Kissimmee Valley:

Shipping point.	Kind of freight.	Tons.	Value.
Kissimmee	Forage and general supplies	1,218.6	$151,346.00
Bassinger	Produce and hides	171.3	37,695.00
Total		1,389.9	189,041.00

The cattle and hogs statistics in the same valley are:

	Head.	Tons.	Value.
Cattle	15,000	2,250	$180,000.00
Hogs	1,000	30	5,000.00

Incidentally, the shipments of the latter from Puntarasa should be noted as follows:

	Head.	Tons.	Value.
Cattle	21,000	3,150	$252,000.00
Hogs	4,000	120	20,000.00

An improvement of the extent desired to the channels above Fort Bassinger would be a direct benefit to the cattle raisers and orange growers on the banks, and primarily to individual interests, but indirectly the general commerce of the State and the country at large would be benefited by the development of this region from which Cuba and the West Indies are even now drawing large supplies of cattle.

In view of the present commerce and the probable great benefit to commerce to be derived from improvements of small extent I am of the opinion that the waterway from Kissimmee, Fla., to Fort Bassinger, Fla., is worthy of improvement by the General Government. I have to recommend that the necessary survey be extended to the mouth of the Kissimmee River, as a study should be made of the stream in its entirety before improvements are undertaken. Such a survey would also practically complete the data for the whole route from Kissimmee to the Gulf of Mexico as the survey of the Caloosahatchee River has already been made (see Captain Black's report, Report Chief of Engineers for 1888, Part II, p. 1095).

A survey as recommended would cost about $4,000. It could not be made until after the high-water period, probably not before January.

An approximate map[a] covering the region under consideration accompanies this report. It was kindly furnished by the associated railway land department of Florida.

Very respectfully, your obedient servant,

HENRY JERVEY,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
August 30, 1899.

Respectfully submitted to the Secretary of War.

In accordance with the provisions of the river and harbor act of March 3, 1899, a preliminary examination has been made of the Kissimmee River and connecting lakes and canals flowing into Lake Okechobee, Florida, thence down the Caloosahatchee River to the Gulf of Mexico, with a view to improving the navigation of the channels therein, and the within report of the results of this examination is submitted for action of the Secretary of War.

It is reported that improvements already made have resulted in securing in the Caloosahatchee River from Fort Thompson to the Gulf of Mexico a depth of water sufficient for the present needs of commerce, and that the waterway from Kissimmee to Fort Bassinger is worthy of improvement, and I recommend that a survey be made and the cost of improvement be estimated, as proposed by Captain Jervey.

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[a] Not printed.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Second indorsement.]

WAR DEPARTMENT,
September 12, 1899.

Approved as recommended by the Chief of Engineers.

By order of the Secretary of War:

A. N. THOMPSON,
Acting Chief Clerk.

APPENDIX 1.

Kissimmee River and connecting lakes and canals, through Lake Okechobee to the Gulf of Mexico.

[Condition of waterway in August, 1899.]

Locality.	Length of channel.	Width of canals, etc.	Soundings, Aug. 1-9, 1899 (in feet).	Nature of bottom and channels.
	Miles.	*Feet.*		
Lake Tohopekaliga	11.50	....	2 to 17	Sand and mud; sand bars.
Southport Canal	4	70	1.8 to 4	Many shoal places.
Cypress Lake	2.50	....	3.5 to 11	Sand and mud.
Seventy-foot Canal	2.25	70	3.3 to 6.7	Sandy.
Lake Hatcheneha	2.25	....	6 to 10	
Hatcheneha Canal	.75	36	3 to 5	
Kissimmee River	[a]2.75	36	3 to 7	Dangerous snag.
Fort Gardner Canal	1.50	36	2.8 to 6	
Lake Kissimmee	18.25	....	2.5 to 12	Sandy; no obstructions.
Kissimmee River	145	[b]100	....	
Ute to Long Hammock	....	....	4 to 10	Shoals and bends.
Long Hammock to Orange Hammock.	....	....	2.5 to 12	
Orange Hammock to Bassinger.	....	....	3 to 9	Snags and bends.
Bassinger to Wolf Island	....	....	3.5 to 10	Sand bars; abrupt bends.
Wolf Island to river's mouth	....	....	4 to 30	One cut-off.
Lake Okechobee	34	....	5 to 11	Hard sand and mud; no obstructions.
Okechobee Canal	3	....	2 to 6.6	Sand underlaid with clay; very shallow in places.
Lake Hikpochee	4	....	2 to 5	Soft mud; shallow.
Canal and river	9.75	....	3 to 7	
Bonnet Lake	.50	....	1.5 to 5	
Canal	1	....	1.4 to 4	Two sand bars.
Lake Flirt	2	....	1.8 to 5	Sand and mud; shallow.
Caloosahatchee River:				
Lake Flirt to Fort Thompson.	4	....	2.5 to 6	Sand and rock; channel narrow and shallow.
Fort Thompson to Alva	....	....	5 to 20	
Alva to Myers	43.50	....	5.5 to 31	Sand; good water; some snags.
Myers to Puntarasa[c]	17	....	6 to 22	Broad and good channel, but tortuous, due to oyster bars.
San Carlos Bay[c]	2.50	....	8 to 25	Sand.

[a] Cut-off.
[b] At entrance.
[c] These depths were taken from the United States Coast Survey chart No. 473.

APPENDIX 2.

REPORT OF MR. W. H. CALDWELL, ASSISTANT ENGINEER.

United States Engineer Office,
Tampa, Fla., August 15, 1899.

Captain: I have the honor to submit the following report on a preliminary examination of—

" Kissimmee River and connecting lakes and canals flowing into Lake Okeechobee, thence down the Caloosahatchee River to the Gulf of Mexico, with a view to improving the navigation of the channels therein."

Acting under your instructions, the examination made was a thorough one. Mr. William P. Jervey, overseer, accompanied me to assist in collecting data and making soundings. We traversed the waterway in both directions, which afforded us exceptional opportunity for observations and the collection of data. This report is arranged in divisions, in order that you may more easily refer to the subjects embraced herein.

DIVISION 1. ITINERARY.

We left Tampa at 7.35 p. m. July 31, 1899, and arrived at Kissimmee, Osceola County, Fla., at 10.40 the same evening. The following morning, Tuesday, August 1, at 8 o'clock, we sailed from Kissimmee on the chartered stern-wheel steamboat *Roseada*, whose master (and owner) is Capt. Clay Johnson. Tuesday night, at 7.30 o'clock, the steamer was moored at Long Hammock Landing, Kissimmee River. On Wednesday morning, August 2, the steamboat was gotten under way at dawn and at dusk was moored at Fort Bassinger, Kissimmee River. At 7 o'clock on Thursday morning, August 3, the steamboat proceeded down the river channel, and at 8 o'clock that evening was brought to anchor in Lake Okechobee, 1 mile northward of the entrance to the upper canal, which connects Okechobee and Lake Hikpochee. The journey was continued at daybreak on Friday, August 4, and we reached Fort Myers that afternoon. Our arrival was communicated to you. Saturday was spent collecting commercial statistics of Myers and Puntarasa and obtaining information about the channels leading to the Gulf of Mexico. Early on Sunday morning, August 6, we started on the return trip. That night the steamboat was anchored at the head of the canal leading from Lake Hikpochee into the Caloosahatchee River. Monday night the vessel was moored at Mrs. J. M. Pierce's Landing, Kissimmee River, and on Tuesday night at Bluff Hammock Landing, in the same river. On Wednesday evening, August 9, at 6.15 o'clock, we reached the steamboat dock at Kissimmee. There we took the train, and arrived in Tampa at 11.30 p. m., having been absent nine days.

DIVISION 2. GENERAL DESCRIPTION.

The flourishing town of Kissimmee is the county seat of Osceola, and is situated on the northwestern extremity of Tohopekaliga Lake. It has a population of 1,000 or more. It being the supply depot for a fruit and vegetable section, as well as for immense cattle ranges, its commercial transactions are very large. The Plant Railway System passes through the town. Two lines of steamers make weekly trips throughout the year (when the stage of water will permit) from Kissimmee to Fort Bassinger, a distance of about 150 miles, and it is reported that a third steamer is now building which will engage in the same traffic. During the winter season small steamers occasionally make the round trip from Kissimmee to Fort Myers with parties of tourists.

The waterway from Kissimmee to the Gulf of Mexico is 309 miles long. Two and one-half miles of the route is through a bay—San Carlos; 75 miles in lakes, viz, Tohopekaliga Lake, Cypress Lake, Hatchencha Lake, Lake Kissimmee, Lake Okechobee, Lake Hikpochee, Bonnet Lake, and Lake Flirt; 213 miles in rivers, to wit, Kissimmee River and Caloosahatchee River; and 18½ miles in canals, namely, Southport Canal, Seventy-foot Canal, Hatchencha Canal, Fort Gardner Canal, Okechobee Canal, and Twelve-mile Canal. The country that is tributary to this waterway covers an area of about 2,500 square miles. Though sparsely settled, its inhabitants are entirely dependent upon the water route for transportation. After leaving the town of Kissimmee not a single point in the area mentioned is on or near a railroad. There are twenty-five landings for steamboats between Kissimmee and Lake Okechobee. Twelve or 13 miles from Turkey Hammock Landing—on the eastern side of Lake Kissimmee—there is an inland community called Lakeview settlement. It has two stores and a post-office, the latter being officially known as Whittier. At the southwestern extremity of Lake Kissimmee is Rattlesnake Hammock Landing, where there is a warehouse and post-office, the latter being officially known as Ute. Alligator Bluff Landing is on the Kissimmee River, and a few miles westward of it is a post-office called Alger. At Fort Bassinger are three stores and a post-office, the official designation of the latter being Bassinger. Fort Drum, 14 miles northeastward from Bassinger, has a post-office and two stores.

There are no landings or settlements on Lake Okechobee. Along Taylors Creek, which empties into the northeastern corner of the lake, are several orange groves. A number are being set out this month, and clearings are under way for more.

The thriving and beautiful village of Fort Myers is the most important settlement on the Caloosahatchee River. A large mercantile business is conducted there, the country around being a prosperous fruit and vegetable section. The post-office is officially designated Myers. The mails are daily, across country by ferry and hack to Punta Gorda, which is a railroad terminus. During the tourist season, namely, from January to May, there are daily steamers between Fort Myers and Punta Gorda. During the remainder of the year the steamer service is three times per week. These steamers carry the mails also. There is an independent line steamer which runs occasionally between Fort Myers and Punta Gorda. Two schooners make semimonthly trips to Tampa. A line of steamers makes trips three times a week to upriver points as far as Fort Thompson, a distance of 43½ miles.

Puntarasa is at the mouth of the Caloosahatchee River, and is 17 miles below Fort Myers. There is a post-office, telegraph and express office there. The steamers plying between Fort Myers and Punta Gorda touch at Puntarasa regularly. Immense quantities of vegetables and fruits are shipped from there. Large numbers of cattle and swine are exported to Cuba from Lee, De Soto, and Osceola counties at this point. Vessels drawing 9 feet can make the anchorage.

There are seven post-offices on the Caloosahatchee River above Fort Myers. Taken in succession—going upstream—they are as follows: Olga, Rialto, Caloosa, Alva, Denand, Labelle, and Fort Thompson. The last place is 23 miles from Lake Okechobee and 43½ miles above Fort Myers. There are two stores at Alva, and a sawmill near by. There is a store and large sawmill at Denand. There is a store at Labelle. Buckingham post-office is about 9 miles across country from Fort Myers. It is on the left bank of Orange River, or Twelve-mile Creek, which empties into the Caloosahatchee above Beautiful Island. Besides the post-office landings, the steamers touch at various points and farms to discharge or receive freight.

DIVISION 3. TOPOGRAPHY.

Lake Okechobee may be considered the central division of this waterway, with the Kissimmee River route (to the northward) on one hand and the Caloosahatchee River route (to the westward) on the other. The extremities of the former route are Kissimmee town and the mouth of the Kissimmee River, on the northern side of Lake Okechobee. The extremities of the latter route are Sanibel Island, at the Gulf entrance, and the head of Okechobee Canal, on the western side of Lake Okechobee. The head of navigation on the Caloosahatchee is Fort Thompson; the lower point of navigation on the Kissimmee is Fort Bassinger. The approximate geographical positions of these points, taken in regular order from north to south, are:

Kissimmee town, latitude 28° 18′ N., longitude 81° 23′ W.
Fort Bassinger, latitude 27° 22′ N., longitude 81° 02′ W.
Mouth of Kissimmee River, latitude 27° 09′ N., longitude 80° 55′ W.
Mouth of Okechobee Canal, latitude 26° 47′ N., longitude 81° 03′ W.
Fort Thompson, latitude 26° 44′ N., longitude 81° 24′ W., and
Sanibel Island light-house, latitude 26° 27′ N., longitude 82° W.

Kissimmee Valley is a nearly level country. It extends about 75 miles in a general north-and-south direction, and has an east-and-west width varying from 10 to 50 miles. The lake region forming the headwaters of Kissimmee River is due west, and only 30 miles distant, from the lakes at the source of St. Johns River—the two rivers flowing in directly opposite directions. Many square miles of the Kissimmee Valley is covered with splendid grass, and the whole country being well-watered, this section has no superior as a cattle range. Slight elevations throughout the valley are densely wooded. Some of them have been cleared and form excellent ground for vegetable farming and orange raising. The borders of the lakes and rivers are generally marshy, along which grow bogrush, bonnets, flags, lovers' vine, ferns, and wild grasses. On the hammocks and along either edge of the valley were seen palmetto, live oak, white oak, pine, and gum trees. Myrtle, maple, sumac, red bay, white bay, cypress, cabbage palms, and willows cover the banks of both river and lake at many places. We watched closely for water hyacinths, but saw none until 5 or 6 miles below Fort Bassinger, in the Kissimmee River. There a small bayou is covered with it, and a few patches were observed along the river's banks for the next several miles. The last 20 miles of the river, from Wolf Island to Lake Okechobee, is bordered by an impenetrable marsh, which extends back from the river for many miles on either side. Thick patches of willow and myrtle are frequent. The vegetation is wild and rank, consisting of grass, water lettuce, smartweeds, wild cotton, bonnets, and flags.

Lake Okechobee's borders are similar to the lower end of Kissimmee River.

The canal from Okechobee into Lake Hikpochee is bordered by a rank growth of willows, water oak, myrtle, grass, wild cotton, and water lettuce. Hikpochee, Bonnet Lake, and Lake Flirt, are surrounded by marshes. Being shallow, the growth of bogrush, cat-tails, bonnets, and flags covers a large portion of their bottoms, and water lettuce and lovers' vines run over many acres of their surface. On either side of the canal leading from western extremity of Lake Hikpochee as well as the canal between Bonnet Lake and Lake Flirt are vast areas of wild millet. Great patches of willows occur here and there, as well as an occasional palmetto hammock. A beautiful grassy prairie commences below Lake Flirt and extends to the wooded region at Fort Thompson. From there to the mouth of the Caloosahatchee River is a finely wooded country. Palmettoes, pines, and oaks predominate. The river's banks are high, as compared with the Kissimmee. Although overflows occur, they subside quickly—largely due to improvements made in the river channel by the United States Government. The Caloosahatchee Valley is about 40 miles long and 20 miles broad. Its soil is rich and productive. Vegetables and all kinds of citrus fruits are largely grown there. Particular watch was kept for the water hyacinth along this route. The first seen was at Alva—42½ miles below Lake Okechobee. From Alva to the mouth of the Caloosahatchee are great patches of water hyacinth and water lettuce.

DIVISION 4. HYDROGRAPHY.

Tohopekaliga Lake, covering an area of about 24,000 acres, is the source of the Kissimmee River. The bottom of the lake is sand and mud. Paradise Island is in the western portion of the lake, while a little farther west and south is Summerlin Island. A sand bar runs across the lake above Paradise Island with a depth over it varying from 1 to 6 feet, dependent upon the stage of water. From the southeastern extremity of the island a sand bar runs into the lake, and there is also one running out from the eastern shore. It is easy to avoid these sand bars if one knows the channels. There are no snags or other like obstructions in the lake. The steamboat route across Tohopekaliga to the Southport Canal is 11½ miles. At the entrance to the canal is a sand bar with only about 2½ feet of water over it. This canal is 105 feet wide and 4 miles long. Only 70 feet of its width was ever dredged to a depth navigable at the ordinary stage of water. The Kissimmee River starts from Tohopekaliga Lake at a point eastward of the canal, and flows into Cypress Lake also eastward of the canal's exit. A portion of the canal is through the old river bed. Nearly all the water from the lake now runs southward through the canal. There are many shoal places in the canal and its lower end is particularly difficult to navigate. The bottom is hard sand.

Cypress Lake is the next link in this chain of waterways. It covers an area of about 6,000 acres, and has a sandy and mud bottom. It is 2½ miles across the lake to the entrance of Seventy-foot Canal. This canal joins Cypress Lake and Hatcheneha Lake. The course of the Kissimmee River between these lakes is westward of the canal. The stream is very crooked and full of snags, but has been navigated by small steamers. The canal is now used for traffic exclusively. It is 70 feet wide, 2¾ miles long, and has a sandy bottom.

Lake Hatcheneha, covering an area of about 10,000 acres, offers no obstruction to navigation. This lake is connected with Lake Kissimmee partly by river and partly by canal. That portion of the Kissimmee River between these lakes, though containing many sharp bends, is wide and navigable. It is 2½ miles across Lake Hatcheneha to the entrance of Hatcheneha Canal. This canal is 36 feet wide and three-fourths mile long. The lower end of this canal joins the river, the river's course from Hatcheneha Lake to that point being west of the canal. From the southern extremity of Hatcheneha Canal is a stretch of 2¾ miles in the river to a point where the Fort Gardner Canal starts. In that portion of the river between the two canals is a cut-off which is 36 feet wide. There is a snag in this portion of the river which is a danger to navigation. Fort Gardner Canal is 36 feet wide and 1½ miles long. It is shallow and its southern entrance is obstructed. The Kissimmee River flows eastward of this cannl. The sketch[a] at the bottom of this page shows roughly the approximate position of the two canals and the cut-off, as well as the river's course between Hatcheneha Lake and Lake Kissimmee.

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[a] Not printed.

Lake Kissimmee, the last one until Okechobee is reached, covers an area of 36,000 acres. Its bottom is sandy and its waters offer no obstruction to navigation. From the canal exit across the lake to the entrance of Kissimmee River is 18½ miles. On this lake are steamboat landings known as Jack Hammock, Shivers Landing, Stokes Landing, Grape Hammock, and Turkey Hammock. On the river between this lake and Hatcheneha Lake are three landings, namely, Shell Hammock, East Gardner, and West Gardner (or Fort Gardner). Southport, a landing on Tohopekaliga Lake, is at the head of the Southport Canal.

Kissimmee River, connecting Lake Kissimmee and Lake Okechobee, is about 145 miles long. It is a sluggish and very sinuous stream. It presents the anomaly of being much wider at its headwaters than at its mouth, though it becomes deeper at its lower end. Entering the river from Lake Kissimmee its width is 100 feet, or more, and its depth varies from 8 to 12 feet. A shoal with about 3 feet over it was found in the river about 2½ miles from Lake Kissimmee. In the first 25 miles of the river's length are twelve cut-offs. About one-fourth mile of the river's channel is very shallow just above Long Hammock. Rattlesnake Hammock, where there is a post-office called Ute, is on the river's right bank just after leaving Lake Kissimmee; and 4 miles farther down is Long Hammock Landing. The next landing is Bay Hammock; then Cabbage Bluff, or Jack Whidden's; Alligator Bluff comes next, and then Orange Hammock, which is 25 miles from Ute. On the right bank of the river, 9 miles farther down, is Fort Kissimmee, just above which landing the river is wide and shallow. Then follow landings at McLaughlins, Prairie Camp, Bluff Hammock, and Mico Bluff. There are two snags in this stretch of the river. Mico Bluff is 45 miles below Orange Hammock. In the vicinity of McLaughlins Landing the river presents a remarkable example of sinuosity. Four sketches* of the river's course there are given here for your consideration.

The first sketch is 1 mile above Long Hammock. The river's course from *a* to *b* is about 2½ miles, and the slope is very small. The distance from *a* to *b* in a straight line is 60 or 70 feet.

The second sketch represents a point on the river one-half mile above Long Hammock. The distance from *a* to *b* in the river channel is nearly 1 mile and the bend at *c* is very sharp. As is evident from the sketch, a vessel bound either up or down the river has to change her course nearly sixteen points (180) at *c*, and it requires a most skillful pilot under such circumstances. Fortunately the river is wider at *c* (as it is at nearly every bend) and affords a vessel additional room for turning.

The third sketch presents the peculiarity of two portions of the river flowing parallel, and in directly opposite directions, for a considerable distance. From *a* to *b* in a straight line is less than 25 feet. This bend is about 1½ miles below McLaughlins Hammock.

The fourth sketch shows an almost circular loop in the river's course. It is about 3½ miles below Long Hammock, the name sometimes given McLaughlins Landing. The distance from *a* to b in a straight line is about 50 feet.

Sketches were made of forty or fifty of the eccentric bends in the river, but on account of the space required for them only one more will be embodied in this report. At the point in question (*c*) the river presents the unique feature of a loop within a loop. This portion of the river is navigable and has a very good depth of water, but the steamers use a cut-off—shown by dotted lines from *a* to *b*. The cut-off is not as straight as the sketch would indicate; still it saves over the regular river route 4 miles in distance. The shorter route is known as Jack Scarborough, or Bumblebee, Cut-off.

Another important cut-off is called "Turtle Mound." Its course is crooked, but is shorter than the regular river. Its upper entrance is abrubt, and is called "Hole-in-the-wall."

The first landing below Mico Bluff is Rob Pierce's, 13 miles down the river. Three miles farther is Laniers Landing; and Bassinger Post-office, commonly called Fort Bassinger, is 9 miles farther. One-half mile below Bassinger Post-office is Mrs. J. M. Pierce's Landing; and 3½ miles farther down the river is old Fort Bassinger. There are sand bars in the river between the two latter landings. In the vicinity of Laniers Landing and Bassinger Landing the river channel is extremely crooked, having many abrupt turns in its course.

Istokpoga Creek, which drains Lake Istokpoga and a large number of adjacent lakes, empties into the Kissimmee River from the westward about 20 miles above Bassinger Post-office. The creek is about 10 miles long, and has many snags in it.

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* Not printed.

An island in Kissimmee River, called Wolf Island, is 26 miles below Bassinger Post-office. In that stretch of the river are two snags and four shoal places. There is one cut-off, which is called Reynolds. Between Wolf Island and Lake Okechobee—a distance of 24 miles—there are no settlements or landings. The river is somewhat narrower than farther upstream, but is very deep.

Lake Okechobee, covering an area of 1,080,000 acres, affords a sufficient depth of water with no obstructions for navigation. There are four large islands in its southern portion. The bottom of the lake is hard sand and mud.

Okechobee Canal, leading from Lake Okechobee into Lake Hikpochee, is 28 feet wide and 3 miles long. The bottom is sand, underlaid with hard clay. The canal is shallow in several places, particularly at its lower end.

Lake Hikpochee, covering an area of 9,000 acres, is shallow. Its bottom is soft mud.

From Lake Hikpochee to Bonnet Lake is a succession of canals and bayou or river channels. The length of the canals aggregates 6 miles, and of the river 3¾ miles. It is 4 miles across Lake Hikpochee and one-half mile across Bonnet Lake.

Bonnet Lake, covering an area of about 500 acres, is shallow, and has a mud bottom.

A canal 1 mile long and about 30 feet wide connects Bonnet Lake and Lake Flirt. A sand bar has formed across it in two places.

Lake Flirt, covering an area of 1,000 acres, is shallow. Its bottom is mud and sand. The channel through it is 2 miles long. The river channel from Lake Flirt to Fort Thompson is 4 miles long. The banks are low, and the channel narrow and shallow. The bottom is sand and rock.

From Fort Thompson to Myers, a distance of 43½ miles, the river's banks are generally high. The bottom is sand, and there is sufficient water for all-the-year navigation. The navigation is obstructed to a certain extent by snags, for when the river overflows the banks cave in and carry the adjacent trees with them.

For a distance of 17 miles, from Myers to the mouth of the Caloosahatchee, the river is broad and has a good channel. Many oyster bars obstruct this portion of the river and cause the channel to be tortuous.

It is 3 miles across San Carlos Bay, from the mouth of the Caloosahatchee to the bar at the entrance leading to the Gulf of Mexico. The least depth in the bay channel is 8 feet. The bottom is sand.

DIVISION 5. SOUNDINGS.

We took frequent soundings throughout the route, and for the sake of brevity they are tabulated below. No soundings were obtained between Myers and the Gulf of Mexico, because the chartered steamer *Roseada*, having no condenser, could not run in salt water. The maximum and minimum depths for each section of the waterway are given.

Maximum and minimum depths.

[August 1-9, 1899.]

Locality.	Depths (in feet).
Tohopekaliga Lake	2 to 17
Southport Canal	1.8 to 4
Cypress Lake	3.5 to 11
Seventy-foot Canal	3.3 to 6.7
Hatcheneha Lake	6 to 10
Hatcheneha Canal	3 to 5
Kissimmee River	3 to 7
Fort Gardner Canal	2.8 to 6
Lake Kissimmee	2.5 to 12
Kissimmee River:	
From Ute to Long Hammock	4 to 10
From Long Hammock to Orange Hammock	2.5 to 12
From Orange Hammock to Bassinger	3 to 9
From Bassinger to Wolf Island	3.5 to 10
From Wolf Island to river's mouth	4 to 30
Lake Okechobee	5 to 11
Okechobee Canal	2 to 6.6
Lake Hikpochee	2 to 5
Canal and river	3 to 7
Bonnet Lake	1.5 to 5
Canal	1.4 to 4
Lake Flirt	1.8 to 5
Caloosahatchee River:	
From Lake Flirt to Fort Thompson	2.5 to 6
From Fort Thompson to Alva	5 to 20
From Alva to Myers	5.5 to 31
From Myers to Puntarasa[a]	6 to 22
San Carlos Bay[a]	8 to 25

[a] These depths were taken from the United States Coast Survey chart No. 478.

DIVISION 6. COMMERCIAL STATISTICS.

The commercial statistics, as furnished by the leading merchants and transportation companies, are separately tabulated for the principal business points. In the table for the town of Kissimmee particular care has been taken to exclude its commerce not transported by water. In the table for Bassinger is included the cattle shipment of the Kissimmee Valley; the cattle, though, are never shipped on the river as a consequence of low water, but are driven to some seaport. In the shipments from Puntarasa are included the Kissimmee cattle, in order to exhibit the freight business from that port. The tables show the approximate quantity of all items shipped or received by water during the year ending December 31, 1898.

Items.	Quantity.	Weight in tons.	Estimated value.
Shipments from Kissimmee.			
Merchandise (groceries, dry goods, furniture, and hardware)	....	307.5	$86,750
Fertilizers	....	22.5	800
Grain	....	370	25,000
Hay	....	17.5	850
Lumber:			
Rough ... feet	36,800	73.6	368
Dressed ... do	48,200	84.4	873
Shingles	92,000	16.1	230
Receipts at Kissimmee.			
Hides ... number	20,000	20	12,000
Oranges ... boxes	5,500	220	14,500
Grape fruit ... do	1,000	40	8,000
Vegetables ... crates	2,250	45	2,250
Honey and sirup	....	2	225
Total shipments and receipts	....	1,218.6	151,346
Shipments from Bassinger.			
Hides (alligator) ... number	3,000	10.5	1,800
Honey, sirup, etc	....	1	100
Cattle ... number	15,000	2,250	180,000
Hogs ... do	1,000	30	5,000
Receipts at Bassinger.			
Merchandise (groceries, dry goods, furniture, hardware, hay, and grain)	....	105	35,000
Lumber:			
Rough ... feet	10,000	20	100
Dressed ... do	16,000	28	240
Shingles	30,000	5.3	105
Orange trees	1,000	1.5	350
Total shipments and receipts	....	*171.3	*37,695

*Neither the weights nor values of cattle and hogs are included in the aggregate figures, because it could not be learned what proportion belonged to Bassinger and how much to other points along the river. The total cattle and hog statistics are summarized in Puntarasa table, anyway.

Items.	Quantity.	Weight in tons.	Estimated value.
Shipments from Labelle.			
Cattle ... number	3,000	450	$36,000
Hogs ... do	1,000	30	5,000
Hides:			
Alligator ... do	30,000	105	15,000
Deer ... do	335	.5	67
Furs:			
Otter ... do	250	.6	1,000
Coon ... do	3,000	.8	750
Receipts at Labelle.			
Merchandise (groceries, dry goods, hay, and grain)	....	11	4,000
Lumber, rough ... feet	15,000	30	150
Shingles	6,000	1	25
Total shipments and receipts	....	*148.9	*20,992

*Neither the weights nor values of the cattle and hogs are included in the aggregate figures. Both are shipped from Puntarasa, and are summarized in that table.

Items.	Quantity.	Weight in tons.	Estimated value.
Shipments from Denand.			
Cattle .... number..	2,000	300	$24,000
Hogs .... do....	1,000	30	5,000
Lumber .... feet..	500,000	1,250	7,000
Hides (alligator) .... number..	2,000	6	1,000
Oranges .... boxes..	175	7	350
Sirup .... gallons..	200	1	100
Receipts at Denand.			
Merchandise (groceries, dry goods, furniture, hay, and grain)	....	15	5,000
Total shipments and receipts	....	[a]1,279	[a]13,450

[a] Neither the weights nor values of the cattle and hogs are included in the aggregate figures. Both are shipped from Puntarasa, and are summarized in that table.

Items.	Quantity.	Weight in tons.	Estimated value.
Shipments from Alva.			
Cattle .... number..	1,000	150	$12,000
Hogs .... do....	1,000	30	5,000
Hides (alligator) .... do....	10,000	30	6,000
Oranges .... boxes..	4,000	160	8,000
Vegetables .... crates..	5,000	150	5,000
Receipts at Alva.			
Merchandise (groceries, dry goods, hay, grain, fertilizers, crate material, etc.)	....	91	30,000
Total shipments and receipts	....	[a]431	[a]49,000

[a] Neither the weights nor values of the cattle and hogs are included in the aggregate figures. Both are shipped from Puntarasa, and are summarized in that table.

Items.	Quantity.	Weight in tons.	Estimated value.
Shipments from Myers.			
Oranges .... boxes..	13,000	585	$29,250
Grape fruit .... do....	1,000	45	10,000
Vegetables .... crates..	200,000	6,000	200,000
Sirup .... gallons..	3,000	16	1,500
Furs:			
Otter .... number..	1,500	1	9,000
Coon .... do....	5,000	.6	1,500
Hides:			
Alligator .... do....	60,000	180	42,000
Cow .... do....	700	14	1,960
Deer .... do....	2,000	1.5	600
Receipts at Myers.			
Merchandise, (groceries, dry goods, hardware, grain, etc.)	....	1,000	300,000
Fertilizers	....	860	30,100
Hay	....	200	4,200
Horses .... number..	100	60	12,500
Total shipments and receipts	....	8,963.6	642,610

In 1897, the year previous to the date of the above tabulated statistics, there was shipped from Myers 24,000 boxes of oranges and 1,500 of grape fruit. It is believed that there will be 40,000 boxes of oranges and 3,000 boxes of grape fruit this year.

Shipments from Puntarasa.

Items.	Quantity.	Weight in tons.	Designated value.
Cattle .... number..	21,000	3,150	$252,000
Hogs .... do....	4,000	120	20,000
Vegetables .... crates..	10,000	300	15,000
Farming supplies, fertilizers, etc	....	500	6,000
Total shipments and receipts	....	3,620	293,000

The commercial statistics in the foregoing tables were kindly furnished by the following gentlemen:

Messrs. W. B. Makinson, C. A. Carson, J. W. Watson, and L. D. Graham of Kissimmee; Mr. Joe Pierce, of Bassinger; Mr. George Hendry, of Labelle; Mr. G. S. Henderson, of Denand; Mr. B. S. Clay, of Alva; Mr. Henry Hertman and Mr. R. A. Henderson, of Myers; and Mr. G. R. Shultz, of Puntarasa.

DIVISION 7. IMPROVEMENTS AND SURVEY.

Parties interested were interviewed along the route. Those living in the Kissimmee Valley are unanimously in favor of improvements that will afford navigation throughout the year from Kissimmee to Bassinger. They ask for a channel 36 inches deep (at low water) and 30 feet wide. The residents of the Caloosahatchee Valley are in favor of a continuation of the excellent improvements inaugurated October 16, 1883. (See Report of the Chief of Engineers for 1884, Part II, p. 1195.) A preliminary examination of this river was made from Lake Okechobee to the Gulf of Mexico in March and April, 1879. (See Report of the Chief of Engineers for 1879, Part I, p. 863.) A complete survey of the river was made by Assistant Engineer J. W. Sackett, under the direction of Capt. W. M. Black, Corps of Engineers, U. S. A., in March, April, and May, 1887. See Report of the Chief of Engineers for 1888, Part II, p. 1095.) Some of the residents along the lower Caloosahatchee and around San Carlos Bay are advocates of a deeper channel at the Gulf entrance.

Some citizens are in favor of improving the entire water route from Kissimmee to the Gulf. Others are opposed to it: (1) Some in the Kissimmee Valley fear that if the channel was improved throughout it would lower the upper lakes so much as to impede rather than aid navigation; (2) those in the Caloosahatchee Valley fear their lands might be injured by the overflows from an increased volume of water. The canals and cut-offs mentioned throughout this report were dredged under the laws of the State of Florida by the Atlantic and Gulf Coast Canal and Okechobee Land Company. The work was done with an intention of draining the Okechobee basin. Indirectly it was a benefit to navigation, for the entire channel is used by steamers at irregular intervals.

I am of the opinion that the commercial interests involved are such as to justify the General Government in improving the Kissimmee River, lakes, and canals from the town of Kissimmee to the warehouse landing near the village of Bassinger. I recommend that a survey of these waters be made, and that it include the lower Kissimmee to Okechobee, and the Istokpoga Creek from Lake Istokpoga to the Kissimmee River. The channel route to be surveyed is 198 miles long, consisting of 155 miles of river, 34½ miles of lake channel, and 8½ miles of canal. The survey would cost about $4,000.

The improvements desired on the Caloosahatchee are really maintenance of the completed project, and can be accomplished with the current appropriation for that river.

The only interests demanding a through route from the Caloosahatchee to the Kissimmee are tourists, but such travel is too insignificant to be worthy of consideration.

I am of the opinion that the entrance to San Carlos Bay is sufficiently deep for the present needs of commerce. If the wonderful prosperity of Lee and De Soto counties continues, the time may come when larger vessels, seeking that carrying trade, will require a deeper channel.

In conclusion of this report, I wish to acknowledge the cheerful and energetic assistance rendered me by Mr. William P. Jervey. Also, both he and I are indebted to Capt. R. A. Hendry, state representative of Lee County; Captain Menge, master of the steamer *Gray Eagle;* Captain Fisher, master of the *St. Lucie;* and Capt. Clay Johnson, master of the *Roseada*, for valuable information and hospitable courtesy. Captain Johnson, who is thoroughly familiar with the route from Kissimmee to Meyers, was untiring in his zeal, and rendered us all needed assistance.

Very respectfully,

W. H. CALDWELL,
Assistant Engineer.

Capt. HENRY JERVEY,
Corps of Engineers, U. S. Army.

SURVEY OF KISSIMMEE RIVER, FLORIDA, FROM KISSIMMEE TO LAKE OKECHOBEE, AND OF ISTOKPOGA CREEK.

UNITED STATES ENGINEER OFFICE,
Tampa, Fla., December 14, 1901.

GENERAL: 1. I have the honor to submit the following report of a survey of the Kissimmee River and connecting lakes and canals flowing into Lake Okechobee, made in accordance with the provisions of the river and harbor act of March 3, 1899. The act provided for a preliminary examination of the above waterways and the Caloosahatchee River to the Gulf of Mexico. This preliminary examination was made in August, 1899, by Mr. W. H. Caldwell, assistant engineer, and was reported on by Capt. Henry Jervey, Corps of Engineers, August 23, 1899.

2. The preliminary examination showed that the waterways could be discussed most clearly in three parts: (1) The part between the town of Kissimmee, situated at the headwaters of the Kissimmee River, and Fort Bassinger, situated on the river 37.5 miles north of Lake Okechobee; (2) the part between Fort Bassinger and Fort Thompson, situated on the Caloosahatchee River, 23 miles west of Lake Okechobee; (3) the part between Fort Thompson and the Gulf of Mexico. It was found that the third part had already been improved by the United States to a degree sufficient for the existing needs of commerce, and that the second part lay mostly through an uninhabited swamp, and that there was no demand for its improvement except for the benefit of an occasional tourist party. The part between Kissimmee and Fort Bassinger was reported worthy of improvement.

3. With a view to securing complete data for the Kissimmee River, Captain Jervey recommended that a survey be made of the entire river from Kissimmee to Lake Okechobee. This was approved, and the survey was ordered by the Chief of Engineers on September 16, 1899. Owing to the fact that a survey is practicable only during a low stage of the river, which occurs ordinarily during the dry winter season, and to the fact that during the winter of 1899–1900 the water did not fall sufficiently low, the survey was deferred until last winter. The field work was done between January 22 and April 24, 1901, by Mr. Caldwell, to whose report, appended hereto, attention is respectfully invited.

4. The survey covered the river from Kissimmee to Lake Okechobee, a distance of 137 miles, and Istokpoga Creek, 9.4 miles long, connecting Lake Istokpoga with the river 10.5 miles north of Bassinger. Of the 137 miles of waterway between Kissimmee and Lake Okechobee, 97.1 miles consist of natural river channel, 7.5 miles of artificial canals and cut-offs, and 32.4 miles of lakes. No difficulty resulting from insufficient depth is found in navigating the lakes and the river proper. There are many difficult bends in the river, but the commerce does not justify the making of cut-offs. The worst shoals are found in Southport and Kissimmee canals, six in the former and one in the latter.

5. The commerce of the river is carried on with boats of light draft, which bring out the products of the valley along the river and carry back the supplies for the inhabitants. One of the great industries is cattle raising. Most of the cattle are not shipped by the river, but are driven to a port on the Gulf of Mexico. The volume of the commerce

of the river for the past year is stated as follows by parties in Kissimmee:

Oranges	boxes	20,000
Vegetables, wool, hides, etc	tons	150
Cattle, live stock	do	375
Lumber, shingles, wire-crate material, general merchandise	do	1,500
Fish, ice, etc	do	50
Other items	do	250
Passengers	number	1,000

The prospective increase in commerce is considerable on account of the large amount of pine and cypress timber in the region and the area of land suitable for the cultivation of vegetables, oranges, and other fruits, and for the raising of cattle. The facts are well stated by Captain Jervey in his report of the preliminary examination, as follows:

> The territory tributary to this water route comprises about 2,500 square miles. It is essentially a cattle country, the mild climate, abundant pasturage, and almost unlimited ranges reducing the cost of raising to a low figure. Orange culture has reached considerable proportions also, and is on the increase. The railroads that parallel this valley on the east and west are from 30 to 50 miles distant, and the cross-country roads are few and swampy, sometimes impassable. They are used only by mail riders, as all supplies are drawn from Kissimmee, being carried on wagons when low water stops navigation.

6. The channel desired by the navigation and commercial interests is one 30 feet wide and at least 3 feet deep at ordinary stage of river, which is rather an elastic term, meaning the stage existing for several months during the middle of the dry season and admitting of no closer definition than that it is a stage about 1 foot above the lowest known stage of the river. To secure this channel it will be necessary to dredge 31,130 cubic yards of material in Southport Canal and 6,153 cubic yards in Kissimmee Canal. Four bulkheads are necessary in Southport Canal, one on each side at the upper end, to prevent sand from being moved into it by wave action, one double bulkhead on west side about midway of the canal to support dredged material, and one sheet-piling bulkhead on the east side near the lower end to preserve the alignment of the channel.

7. The channels to be dredged must be kept as narrow as possible in order to avoid causing the water of the river to run off more rapidly during the dry season than it does already, thereby draining the sources of supply. With this in view, the cuts will be limited to a width of 30 feet and the dredged material will as far as possible be so disposed as to restrict the flow during low stages to the 30-foot channel.

8. Istokpoga Creek is a short stream, the outlet of the lake of the same name. Its navigation is obstructed chiefly by four small shoals and by a large number of snags and overhanging trees. Steamers formerly ran up this creek, but have ceased to do so on account of the difficulties of navigation. There are a few settlements on the creek and lake, and it is believed that if the creek were improved a large increase in population and commerce would result on account of the desirable agricultural land and cypress timber to be found in the vicinity.

9. The unit prices of work in these waters will be high because of their distance from centers of business. The cost of dredging in Istokpoga Creek has been placed especially high on account of the fact that to take a dredge there and return will cost a great deal more than the actual work of excavation.

10. The estimated cost of the improvements proposed is as follows:

Southport Canal, dredging 31,130 cubic yards, at 30 cents	$9,339.00
Kissimmee Canal, dredging 6,153 cubic yards, at 30 cents	1,845.90
Southport Canal:	
Bulkhead, east side upper end	850.00
Bulkhead, west side upper end	1,005.00
Bulkhead, west side midway of canal	5,920.00
Bulkhead, east side lower end	460.00
Engineering and contingencies	2,900.00
Total for Kissimmee River and connections	22,319.90
Istokpoga Creek:	
Dredging 332 cubic yards, at $1.50	498.00
Removing 50 snags, at $5	250.00
Trimming 602 trees, at $1.50	903.00
Engineering and contingencies	250.00
Total	1,901.00
Total for whole improvement	24,220.90

11. It is believed that the expenditure of the above sum is justified by the interests involved, and the improvement is therefore recommended.

12. Fifteen tracings showing the results of the survey are forwarded herewith.

Very respectfully, your obedient servant,

HERBERT DEAKYNE,
Captain, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Baltimore, Md., December 23, 1901.

1. Respectfully submitted to the Chief of Engineers, United States Army.

2. The level of Lake Tohopekaliga is about 45 feet above the level of Lake Okechobee, the latter being about 20½ feet above the level of the sea. The fall from the former to Lake Okechobee is concentrated chiefly in short sections of the canals connecting the lakes, and in the Kissimmee River. A 3-foot navigation is all that is contemplated, but it is evident that any increase in the dimensions of the canals or channels connecting the lakes will tend to drain off the water and lower the pool above. The district engineer is of the opinion that the small increased cross section which he proposes will not cause a large increase in the outflow. He therefore proposes to limit the width of the cut to 30 feet.

3. The survey does not disclose the sources of water supply to Lake Tohopekaliga. As the maps do not indicate any streams of consequence entering into the lake, it is supposed that the principal water supply must be from rain falling directly on the lake and a comparatively small watershed.

4. I doubt very much whether the small quantity of work estimated for will be of any material benefit, but as the project calls

for a very small appropriation the improvement is recommended as worthy of being undertaken by the Government to the extent of the amount estimated.

PETER C. HAINS,
Colonel, Corps of Engineers,
Division Engineer, Southeast Division.

REPORT OF MR. W. H. CALDWELL, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Tampa, Fla., November 30, 1901.

CAPTAIN: I have the honor to submit the following report of survey of Kissimmee River and connecting lakes and canals flowing into Lake Okechobee. The survey was made under verbal instructions given me by your predecessor, Capt. Thos. H. Rees, Corps of Engineers, U. S. Army.

The surveying party consisted of 1 transit man, 2 recorders, 2 rodmen, 1 master of steamboat, 1 steamboat engineer, 1 boatman, 1 cook, and myself. The party left Tampa January 21, 1901, and boarded the steamer *Roseada* at Kissimmee. Field work of the survey actually began the following day. The *Roseada* is a light-draft stern-wheel steamer and was chartered for a quarter boat during the survey. Field work was completed April 24, 1901, and the surveying party returned to Tampa that evening.

(1) WATERWAY, AREAS, AND DISTANCES.

The waterway surveyed extends from Lake Tohopekaliga to Lake Okechobee, including Istokpoga Creek—the largest affluent of the Kissimmee River. The town of Kissimmee is on the northwestern shore of Lake Tohopekaliga. The southern end of that lake is connected with Cypress Lake by Southport Canal. The navigable water leading from the latter lake into Lake Hatcheneha is Hatcheneha Canal. The two lakes (Cypress and Hatcheneha, are also connected by Kissimmee River, which lies westward of the canal. Lake Hatcheneha is connected with Lake Kissimmee by the Kissimmee River. Lower part of the river is not navigable. Steamboats use the Kissimmee Canal, which leaves the river 0.2 mile below Fort Gardner and connects with the lake westward of the river. Lake Kissimmee is connected with Lake Okechobee by the Kissimmee River. Istokpoga Creek empties into Kissimmee River from the westward 47 miles below Lake Kissimmee.

The area of Lake Tohopekaliga is 32 square miles; of Cypress Lake, 6 square miles; of Lake Hatcheneha, 10 square miles, and of Lake Kissimmee, 61 square miles.

Length of Southport Canal is 3.8 miles; of Hatcheneha Canal, 2.4 miles; of Kissimmee River, from Lake Hatcheneha to upper end of Kissimmee Canal, 2.1 miles; of Kissimmee Canal, 1.3 miles; of Kissimmee River, from Lake Kissimmee to Lake Okechobee, 95 miles, and of Istokpoga Creek, from its junction with the Kissimmee River to Lake Istokpoga, 9.4 miles.

Distances from the town wharf at Kissimmee to landings or other points along the route are tabulated below:

From—	To—	Statute miles.	Remarks.
Town of Kissimmee	Upper end of Southport Canal.	10.8	Distance measured on course passing eastward of Paradise Island.
Do	Lower end of Southport Canal.	14.6	
Do	Upper end of Hatcheneha Canal	16.4	Distance across Cypress Lake measured on a direct course between Southport and Hatcheneha canals.
Do	Lower end of Hatcheneha Canal	18.8	
Do	Kissimmee River entrance, southeast end of Lake Hatcheneha.	22.3	
Do	Tatmans Landing	22.5	
Do	West Gardner Landing	23.5	
Do	East Gardner Landing	23.9	
Do	Fort Gardner Landing	24.2	
Do	Upper end of Kissimmee Canal.	24.4	
Do	Lower end of Kissimmee Canal.	25.7	

From—	To—	Statute miles.	Remarks.
Town of Kissimmee	Grape Hammock Landing, south end of Lake Kissimmee, west side.	39.2	
Do	Turkey Hammock Landing, south end of Lake Kissimmee, east side.	40.4	
Do	Kissimmee River entrance, south end of Lake Kissimmee.	42.0	Distance measured on direct course passing eastward of Brahma Island.
Do	Long Hammock Landing	45.3	
Do	R. Godwin's Landing	50.7	
Do	East end of ditch leading to E. Godwin's warehouse.	52.7	
Do	Cabbage Bluff Landing	54.3	
Do	Alligator Bluff Landing	56.5	
Do	Orange Hammock Landing	59.3	
Do	Fort Kissimmee Landing	64.0	
Do	Upper end of Joe Guy Cut-off	65.9	
Do	Lower end of Joe Guy Cut-off	66.6	
Do	McLaughlins Landing	70.8	
Do	Bluff Hammock Landing	78.8	
Do	Hole-in-the-Wall	80.1	
Do	Upper end of Turtle Mound Cut-off.	82.6	
Do	Lower end of Turtle Mound Cut-off.	82.7	
Do	Micos Landing	87.2	
Do	Mouth of Istokpoga Creek	89.0	
Do	Upper end of Bumblebee Cut-off.	91.5	
Do	Lower end of Bumblebee Cut-off.	92.7	
Do	Upper end of Jack Scarborough Cut-off.	93.1	
Do	Lower end of Jack Scarborough Cut-off.	94.0	
Do	Laniers Landing	95.6	
Do	Warehouse at proposed new landing for Bassinger.	97.4	
Do	Bassinger Landing	99.5	
Do	Mrs. J. M. Pierce's Landing	100.2	
Do	Loftons Landing	102.7	
Do	Peeples Landing	104.8	
Do	Lambs Landing	105.1	
Do	Jake Morgan's Landing	108.7	
Do	Platts Bluff Landing	112.4	
Do	Wolf Island Bluff Landing	118.7	
Do	Wood Landing—opposite big maple tree.	136.0	This landing is on right bank of river 1 mile above Lake Okechobee.
Do	Lake Okechobee	137.0	

(2) SURVEY OF THE LAKES.

The upper portion of Lake Tohopekaliga was triangulated, the system extending as far south as Flemings Island. A base line was measured at the town of Kissimmee, on the mall that is situated eastward of the S., F. and W. Railway depot. The base was measured with a steel tape 100 feet long, supported on the ground throughout its length and a pull of 12 pounds exerted on the tape at every measurement of 100 feet. Three measurements of the base line were made. Its mean length is 2,200.043 feet, with a probable error of about 1 in 110,000.

The system of triangulation could not be extended southward of Flemings Island because the telescopes of the transits at hand were not of sufficient power to see triangulation stations across that portion of the lake. Perhaps the observations might have been obtained had the weather and other conditions been more favorable. During the survey of Tohopekaliga the atmosphere was hazy mornings and evenings, and a heavy smoke overhung the lake constantly, it being the season when cattlemen were firing the surrounding prairies.

The shore line of that portion of the lake not triangulated, as well as the stretches between the triangulation stations, was run in with transit and stadia.

A system of triangulation was extended over the whole area of Cypress Lake, with a base line on the northeastern shore. The base was measured with a 100-foot steel tape, supported on the ground throughout its length, and a pull of 12 pounds exerted on the tape at every measurement. The base line was measured twice. The mean length is 3,200.01 feet, with a probable error of about 1 in 475,000.

The shore line between the triangulation stations, except a portion on northern side of the lake adjacent to entrance of Southport Canal, was run in with transit and stadia. On both sides of this canal entrance is a deep marsh. From boats flagstakes were set at points along edge of the marsh. A secondary base line, 1,000 feet long, was measured on dry ground at western bank of the canal. The base is nearly perpendicular to the shore line. From its extremities angles were read to the flagstakes, and their locations thence determined.

A system of triangulation was devised to cover the whole area of Lake Hatcheneha. The base line is broken, the two measured sides having termini on the southeastern shore of the lake's northern arm, but the greater portion of either side extends across shoal waters. The sides were measured with a 100-foot steel tape, supported on stakes 100 feet apart driven level with the lake surface, and a pull of 18 pounds exerted on the tape at every measurement. The base was measured but once, on account of the water through which it was necessary to wade being very cold and the consequent apprehension that members of the surveying party might become sick.

The angle between the two sides was observed, and the broken base was reduced to a straight line.

The eastern shore of the lake and portions of its northern and southern shores were run in with transit and stadia. The remainder of the shore line, where the marshes and open water of the lake meet, was determined by secondary triangulation.

Nearly all of Lake Kissimmee was triangulated, the base line of the system being on the western shore, south of Kissimmee Canal entrance. A portion of the western area of the lake in the vicinity of Brahma Island was not triangulated; the transit telescopes were of insufficient power to see across the lake at that point. The base was measured with a 100-foot steel tape, supported throughout its length on the ground, and a pull of 12 pounds exerted on the tape during every measurement. The base was measured twice. The mean length is 2,449.98 feet, with a probable error of about 1 in 180,000.

The larger portion of the eastern shore, and some of the western shore, were run in with transit and stadia between the triangulation stations. The remainder of the shore line, where the marshes and open water of the lake meet, was determined by secondary triangulation.

Points on the islands in Lake Kissimmee were established by triangulation from the nearest shore stations. The islands were circuited with transit and stadia from the established points.

(3) MAGNETIC VARIATION.

The magnetic variation of the needle was determined at three places, each being approximately in the middle of a zone covering one-third of the total area of survey. The places of observation, methods used, variation determined, and dates are tabulated below:

Place.	Methods.	Variation.	Date.
		° ′ ″	1901.
Bank on east side of Southport Canal, northern shore of Cypress Lake.	Azimuth of * Polaris at west elongation.	1 31 18 E.	Feb. 6
Prairie on left bank of Kissimmee River at Alligator Bluff Landing.	Equal altitudes of ☉	2 02 00 E.	Mar. 7
Left bank of Kissimmee River at Wolf Island Bluff Landing.	Azimuth of * Polaris at west elongation.	1 50 54 E.	Mar. 28

The variation used for platting the lake and canal charts was 1° 31′ E.; for Kissimmee River from Lake Kissimmee to Bassinger Landing, 2° 02′ E.; for Istokpoga Creek, 2° 02′ E.; and for Kissimmee River from Bassinger Landing to Lake Okechobee, 1° 51′ E.

(4) SURVEY OF THE CANALS, RIVER, AND CREEK.

The connecting waterways between the upper lakes, namely, Southport Canal, Hatcheneha Canal, and Kissimmee River, and Kissimmee Canal, were surveyed with transit and stadia. The stadia stations at end of each were tied to a triangulation or stadia station of the adjacent lake's survey.

Beginning at the triangulation station farthest south in Lake Kissimmee a transit and stadia survey was made of Kissimmee River to its mouth at Lake Okechobee.

From the stadia station on Kissimmee River nearest the mouth of Istokpoga Creek a transit and stadia survey was made to the creek's source at Lake Istokpoga.

(5) DIFFERENTIAL LEVELING.

Lines of levels were run along the waterways between the lakes, from which the elevations (above the level of Lake Okechobee) of the bench marks and turning points were deduced. The elevation of Lake Okechobee above the mean low-water level of the Gulf of Mexico was determined from a bench mark on west side of the lake at head of Okechobee Canal. This bench mark was established by a United States Engineers' surveying party in 1887. Having found the elevation of Lake Okechobee above the Gulf of Mexico, the elevation of bench marks and stations of the Kissimmee River survey were reduced to the same datum plane.

Elevations on April 2, 1901, of the lake surfaces and of three places on the Kissimmee River are given in the following table:

Name.	Height above mean low-water level of Gulf of Mexico.
	Feet.
Lake Okechobee	20.42
Kissimmee River, at Bassinger Landing	35.08
Kissimmee River, at mouth of Istokpoga Creek	41.21
Source of Istokpoga Creek, Lake Istokpoga	49.03
Kissimmee River, at Fort Kissimmee Landing	51.63
Lake Kissimmee	60.28
Lake Hatcheneha	62.30
Cypress Lake	63.45
Lake Tohopekaliga	65.26

(6) BENCH MARKS AND GAUGES.

Bench marks were established at both ends of the several canals, at the source and mouth of Kissimmee River and of Istokpoga Creek. Bench marks were also established on the lakes' shores and along the river course, and the water surface referenced to them by very careful leveling.

Staff gauges, divided into feet and tenths, were established in the lakes, canals, river, and creek. A gauge was always kept near the particular field of work. The gauges were set with their zeros about one foot below the ordinary level of the water course surface. The first gauge established was at the town wharf in Kissimmee. The next one had its zero secured at the same level below surface of water by simultaneous readings of the two gauges.

In this manner each gauge was set with its zero the same depth below the water surface as the one established last preceding it.

The location and description of all bench marks are given in the following table:

Bench marks.

Place.	Description.	Elevation above datum plane.	Elevation above adjacent water surface, and date.
		Feet.	
Outer end of Kissimmee town wharf, Lake Tohopekaliga.	Horizontal row of 5 wire nails on south face of a pile under northwest corner of bath house at outer end of town wharf.	70.68	4 feet, Jan. 24.
Northerly side of Stewart street, 50 feet east of S., F. and W. Rwy., Kissimmee, Fla.	Top of 3-inch iron pipe, 8 feet long, driven 2 feet 8 inches into ground. Pipe is 4 feet north 50° 31′ east true, from △ A of Lake Tohopekaliga survey.	72.14	5.46 feet, Jan. 24.
Upper end of Southport Canal.	Top of 3-inch iron pipe, 1.5 feet long, driven flush with earth. Pipe is on high ground near Jim Zambito's wagon gate, about 20 feet east of canal edge. Pipe is opposite to inshore end of row of piles standing along west edge of canal.	72.35	5.87 feet, Jan. 31.

Bench marks—Continued.

Place	Description.	Elevation above datum plane.	Elevation above adjacent water surface, and date.
		Feet.	
North shore of Cypress Lake, near Southport Canal entrance.	Top of 3-inch iron pipe, 1.5 feet long, driven flush with earth. Pipe is on west side of Southport Canal entrance, about 50 feet from edge of lake.	65.36	0.99 foot, Feb. 4.
Lower end of Presidents Cut, 1.4 miles from upper end of Hatcheneha Canal.	Top of 3-inch iron pipe, 1.5 feet long, driven 14 inches into the earth. Pipe is on crest of embankment, east side of canal, 10 feet from edge of water.	67.97	4.36 feet, Feb. 8.
East shore, Lake Hatcheneha.	Top of 1.5-inch iron pipe, 1.5 feet long, driven 17 inches into the earth. Pipe is in a clump of cypress trees on the most southern dry point of land on east shore. Three cypress trees, 10 feet from pipe, are blazed on sides facing it.	63.62	0.74 foot, Feb. 13.
Kissimmee River, near upper end of Kissimmee Canal.	Horizontal row of 4 wire nails driven into northwest face of small oak tree that stands on high bank west side of upper end of Kissimmee Canal.	67.04	5.34 feet, Feb. 16.
Northeast extremity of peninsula between Tiger Creek Cove and Kissimmee Canal entrance.	7 wire nails in a horizontal row driven into northerly face of oak tree at northeast edge of woods. The 3 central nails are close together and protrude 1¼ inches. Others were driven flush with a space of 2 inches between them.	64.52	3.89 feet, Feb. 26.
Northeast end of Brahma Island, Lake Kissimmee.	Top of 1.5-inch iron pipe, 18 inches long, driven level with earth. The pipe was set 15 feet from edge of lake where there are neither trees nor grass.	60.80	0.27 foot, Feb. 26.
R. Godwin's Landing, left bank of Kissimmee River.	Line between 2 horizontal rows of 4 wire nails driven flush in corner plank of north side of Mr. Godwin's warehouse.	61.88	4.65 feet, Mar. 5.
Corner post of warehouse at Cabbage Bluff Landing, right bank of Kissimmee River.	A horizontal row of 5 wire nails driven into north face of southeast corner post of Jack Whidden's warehouse. Heads of the nails are bent over and down against the post.	59.73	3.98 feet, Mar. 5.
Warehouse at Alligator Bluff Landing, left bank of Kissimmee River.	Line between two horizontal rows of four nails driven into outside face of sill post at northwest corner of warehouse. The lower nails are turned down against the sill.	59.95	5.34 feet, Mar. 6.
Large oak tree at Orange Hammock Landing, right bank of Kissimmee River.	A horizontal row of five wire nails driven into north face of tree about 2 feet above the ground. The nails protrude 1 inch.	60.33	6.72 feet, Mar. 8.
Dead oak tree at Fort Kissimmee Landing, right bank of Kissimmee River.	A horizontal row of five wire nails driven into southeast face of dead oak about 4 feet from ground. Tree stands in a field and is 150 feet from river.	60.60	8.81 feet, Mar. 9.
Lower end of Turtle Mound Cut-off, right bank of Kissimmee River.	Top of 3-inch iron pipe, 18 inches long, driven 14 inches into earth. Pipe stands on narrow bank ridge that was 1 foot above river surface on Mar. 15, 1901. A 2 by 4 inch scantling, projecting 10 inches above ground, is just south of the iron pipe.	45.83	1.31 feet, Mar. 15.
Oak tree at Micos Landing, left bank of Kissimmee River.	A horizontal row of four wire nails driven in northwest face of an oak tree that stands about 20 feet from edge of river. Nails are about 2 feet above ground and ¾ inch apart. Facing the row left nail protrudes 1 inch, right one ¼ inch, and middle two were driven flush with wood.	48.26	6.01 feet, Mar. 16.
Twin willow near upper end of Jack Scarborough Cut-off, left bank of Kissimmee River.	Three wire nails in horizontal row driven flush on north side of a twin willow tree. Nails are just above the ground. Willow stands at edge of river.	42.61	4.99 feet, Mar. 18.
Warehouse at Laniers Landing, right bank of Kissimmee River.	Five wire nails in horizontal row on west side of warehouse, 6 inches from ground.	42.32	5.66 feet, Mar. 19.

Bench marks—Continued.

Place.	Description.	Elevation above datum plane.	Elevation above adjacent water surface, and date.
		Feet.	
Cabbage palmetto at Laniers Landing, right bank of Kissimmee River.	Four wire nails in horizontal row on north face of cabbage palmetto, driven flush, about 12 inches from ground. Tree stands about 50 feet west of warehouse, and 20 feet south from edge of river.	41.56	4.90 feet, Mar. 19.
Warehouse at proposed new Bassinger Landing, left bank of Kissimmee River.	Five nails in a horizontal row driven flush on north side of northwest sill post of warehouse at a height of 3.3 feet from ground.	39.98	3.83 feet, Mar. 19.
Tree on left bank 2.1 miles below Platts Bluff Landing, Kissimmee River.	Single wire nail driven into willow. Nail protrudes ¼ inch. Willow is blazed on southeast side; it stands on edge of bank and overhangs the river.	30.41	0.49 foot, Mar. 24.
Cabbage palmetto on left bank at Wolf Island Bluff Landing, Kissimmee River.	Five nails in a horizontal row, ¼ inch apart, driven in a step 3 feet from ground on west side of a palmetto nearest the river's edge. Middle nail was driven flush; others protrude ¼ inch.	32.23	4.36 feet, Mar. 24.
Big maple tree on left bank opposite wood landing, 1 mile above Lake Okechobee, Kissimmee River.	Five wire nails in horizontal row driven in blazed space on north face of maple tree. All except middle nail protrude 1 inch.	25.40	4.44 feet, Apr. 1.
Cypress tree on right edge of Istokpoga Creek, near Lake Istokpoga.	Five wire nails in a horizontal row driven in step cut on northwest face of tree. Middle nail was driven flush; one on either side protrudes ¼ inch; and the two outer ones protrude ¾ inch.	33.34	5.11 feet, Apr. 11.

(7) SOUNDINGS AND BORINGS.

Soundings were taken with wooden rods, graduated to feet and tenths. No attempt was made to sound the whole area of the lakes, there being ample depths in them to meet the requirements of navigation. Lines of soundings were run between certain triangulation stations and along the routes usually followed by the Kissimmee steamers. In Lake Tohopekaliga, north of Paradise Island, a shoal was developed by soundings across it.

A mid-channel line of soundings was obtained in the canals, and soundings across the channels were taken at the shoal places. The entrances at upper and lower ends of Southport Canal and at lower end of Kissimmee Canal are very shoal. Sufficient soundings were taken across the shoals to develop their contours.

In Kissimmee River and Istokpoga Creek mid-channel lines of soundings were obtained; also a cross-channel line of soundings was taken about every half mile of the channel course.

Character of the bottom was obtained and recorded whenever soundings were taken. Borings were made in the shoal areas of the canals. To a depth of 6 feet below the ordinary stage of the canals fine white sand underlaid by hardpan was found in Southport Canal, coarse sand and mud in Hatcheneha Canal, and fine white sand in Kissimmee Canal.

(8) DISCHARGE OF STREAMS.

Gaugings of the flow of the streams were made above the inlets and below the outlets of the lakes and at intermediate points where conditions were especially favorable for the purpose. On the Kissimmee River between Lake Kissimmee and Lake Okechobee the actual gaugings were made some distance from the lakes, in order that advantage might be taken of straight reaches where the banks are parallel and the channel uniform in cross section.

Double floats were used to obtain the velocity of the current. The lower float was immersed nine-tenths depth of channel. Minimum distance between any set ranges was 200 feet; the maximum, 500 feet. Cross sections were taken at intervals of 50 feet along the gauged length. The floats were started in mid-channel 100 feet above the upper range, and the spaces between them at the starting point did not exceed 20 feet.

The slopes of the water surface between the upper and lower ends of the gauged portions were accurately determined.

The character and material of banks and bottom were noted.

Two gaugings at the same point were made at different stages of the stream wherever practicable. In fact, it was done at every point except at the lower end of the Kissimmee River and on Istokpoga Creek. Those two points were gauged just before conclusion of the survey. To have obtained a second gauging of them necessitated waiting for a change of stage, and that involved more expense than the survey funds would allow.

Results of the gaugings are embodied in the following table:

Gaugings.

Place where gauging was made.	Date.	Stage of stream.	Character and material of banks.	Character and material of bottom.	Distance of extreme ranges.	Slope of water surface between extreme ranges.	Average velocity of stream per second.	Volume of discharge per second.
	1901.				*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*
Upper end of Southport Canal.	Feb. 2	Ordinary.....	High, 8-10 feet; fine sand.	Hard sand; mud near lower range.	250	0.043	0.9450	328.9
Do..........	Apr. 23	Low; 1.04 feet below stage of Feb. 2.	High, 9-11 feet; fine sand.	.....do........	250	0.011	0.6290	164.0
Lower end of Southport Canal.	Feb. 4	Ordinary.....	Right bank, firm mud and sand; left bank, black soft mud. Elevation above water, 0.4-1.6 feet.	Black mud...	250	0.038	1.4910	291.3
Do..........	Apr. 23	Low; 1.04 feet below stage of Feb. 4.	Right bank, firm mud and sand; left bank, firm black mud. Elevation above water, 1.4-2.6 feet.	.....do........	250	0.008	1.3780	155.3
Upper end of Hatcheneha Canal.	Feb. 8	Ordinary.....	Stiff mud. Elevation above water, 1.7-4.6 feet.	Sticky mud...	300	0.037	0.9786	303.9
Do..........	Apr. 22	Low; 1.3 feet below stage of Feb. 8.	Stiff mud. Elevation above water, 3-5.9 feet.	.....do........	300	0.011	0.9448	153.2
Lower end of Hatcheneha Canal.	Feb. 9	Ordinary.....	Right bank, soft mud; left bank, marsh. Elevation above water, 0.0-2.1 feet.	Very soft mud.	300	0.044	1.0966	245.8
Do..........	Apr. 22	Low: 1.3 feet below stage of Feb. 9.	Right bank, firm black mud; left bank, soft mud. Elevation above water, 1.3-3.4 feet.	.....do........	300	0.012	0.9657	152.2
Kissimmee River (just below Lake Hatcheneha) near Shell Hammock Cut-Off.	Feb. 19	Ordinary.....	Right bank, marsh; left bank, stiff mud and clay.	Hard mud or clay.	200	0.012	1.2198	655.9
Do..........	Apr. 18	Low: 0.9 foot below stage of Feb. 19.	.....do............	.....do........	200	0.006	0.7757	317.5
Kissimmee River, near upper end of Kissimmee Canal.	Feb. 19	Ordinary.....	Right bank, firm mud and sand; left bank, soft mud. Elevation above water, 0.0-1.6 feet.	Mud and sand	300	0.043	1.3421	598.2

Gaugings—Continued.

Place where gauging was made.	Date.	Stage of stream.	Character and material of banks.	Character and material of bottom.	Distance of extreme ranges.	Slope of water surface between extreme ranges.	Average velocity of stream per second.	Volume of discharge per second.
	1901.				*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*
Kissimmee River, near upper end of Kissimmee Canal.	Apr. 18	Low: 0.9 foot below stage of Feb. 19.	Right bank, firm mud and sand; left bank, firm mud. Elevation above water, 0.9-2.5 feet.	Mud and sand	300	0.016	0.8628	296.6
Lower end of Kissimmee Canal.	Feb. 17	Ordinary.....	Fine white sand. Elevation above water, 0.7-8.4 feet.	Hard sand....	300	0.063	1.2758	223.2
Do..........	Apr. 18	Low: 0.9 foot below stage of Feb. 17.	Fine white sand. Elevation above water, 1.6-9.3 feet.	.....do........	300	0.019	0.9448	97.3
Upper end of Kissimmee River, near Cabbage Bluff Landing.	Mar. 12	Ordinary.....	Right bank, stiff black soil; left bank, ridge of sand. Elevation above water, 0.0-2.8 feet.	.....do........	500	0.028	1.3945	1120.4
Do..........	Apr. 15	Low: 0.5 foot below stage of Mar. 12.	Right bank, stiff black soil; left bank, ridge of sand. Elevation above water, 0.5-3.3 feet.	.....do........	500	0.030	1.3264	979.4
Lower end of Kissimmee River, near Peeples Landing.	Mar. 23	Low..........	Right bank, hard earth, with rock at depth of 3 feet; left bank, narrow ridge of sand. Elevation above water, 0.4-2.9 feet.	.....do........	500	0.029	1.3141	1216.7
Istokpoga Creek, 1 mile below Waldrons Ferry.	Apr. 13	.....do........	Right bank, marsh; left bank, stiff black soil. Elevation above water, 0.0-2.4 feet.	Hard mud....	200	0.033	1.5469	140.2

(9) SNAGS AND OVERHANGING TREES.

Kissimmee River is remarkably free from snags and overhanging trees. None of the overhanging trees are of enough consequence to interfere with navigation. There are 10 snags, located as follows: One near right bank of river, 2.4 miles below mouth of Istokpoga Creek; three near right bank of river, situated 1,650, 1,765, and 2,055 feet, respectively, below Mrs. J. M. Pierce's Landing; one near right bank, 2,600 feet above Jake Morgan's Landing; one near right bank, 8,150 feet below Jake Morgan's Landing, and one near left bank, 8,260 feet below same landing; one near right bank, 2,000 feet below Platts Bluff Landing, one in midstream 3,775 feet below the landing, and one near left bank, 4,400 feet below the same landing.

There are no snags in the canals, and no overhanging trees along them sufficient to interefere with navigation.

There are 50 snags and 602 overhanging trees along Istokpoga Creek. Of the overhanging trees 314 are on the right bank and 288 on the left bank. The creek is 9.4 miles long. The obstructions to navigation begin 1.8 miles above the mouth of the creek and continue at varying intervals from there to Lake Istokpoga.

(10) MAPS, DIAGRAMS, AND RECORDS.

Maps of the lakes, canals, and river and creek have been platted from the survey records. These show the triangulation and stadia stations, general topography, and soundings. The lake maps were platted on a scale of 1:30,000, the canal maps 1:2,400, the river and creek maps, 1:4,800.

A general map (scale 1:126,720) shows the whole area surveyed. Tracings of the maps, fifteen in number, are submitted with this report.

A profile sheet has been made of the entire water course from Tohopekaliga to Okechobee, showing the elevations at important points. Diagrams have been made of the course and sectional areas of the streams where gaugings were taken.

The records of the survey consist of the following:

One daily journal of operations.
Two triangulation books.
Thirteen transit and stadia books.
Ten soundings books.
One book of levels.
Two books of current observations.
One book of gauge readings and bench-mark locations.
One book describing triangulation stations.

(11) DEDUCTIONS AND ESTIMATES.

A navigable channel 3 feet deep at the ordinary stage of water may be obtained by comparatively little dredging. If narrow channel sections are cut, the volume of discharge might be sufficiently controlled to afford a navigable depth throughout the year.

During the past seven years navigation on this water course has been interrupted four times by low water. In 1895 navigation was stopped five months, in 1897 for eight months, in 1898 for five months, and in 1901 for two months. A study of the table of volumes of discharge of the several streams makes evident that the headwaters (Lake Tohopekaliga and tributaries) must be conserved. Therefore the outlet of the lake for ordinary stage must be narrow, but of sufficient depth for passage of steamers. For higher stages of water the outlet must be larger, which may be obtained by widening the opening but not digging it so deep as the low-water outlet. There is ample water in the river and lakes at any stage for navigation. The river course could be improved by dredging a number of cut-offs, but it would entail large expense.

The survey shows that the following shoal places must be dredged to give a navigable channel 3 feet deep; 3 at upper end, 1 near middle, and 2 at lower end of Southport Canal; 1 at entrance of lower end of Kissimmee Canal; and 4 in Istokpoga Creek. Bulkheads are necessary on both sides of entrance at upper end of Southport Canal to prevent sand being moved into it by wave action. Parallel bulkheads for holding material of training wall on west side of canal near its middle length are required; also a single bulkhead near lower end of the canal to stop outlet into marsh. There are 50 snags and 602 overhanging trees to be removed from Istokpoga Creek.

Estimate for improvement of waterway between the town of Kissimmee on Lake Tohopekaliga and Bassinger Landing on Kissimmee River.

DREDGING.

Place.	Number of shoal.	Section.			Cubic yards.	Price per yard.	Cost.
		Length.	Width.	Depth.			
						Cents.	
Upper end of Southport Canal	No. 1	396	30	3	831	30	$249.30
Do	No. 2	28	30	3	47	30	14.10
Do	No. 3	130	30	3	336	30	100.80
Middle of Southport Canal	No. 4	3,280	60	3	17,852	30	5,355.60
Lower end of Southport Canal	No. 5	400	60	3	1,114	30	334.20
Do	No. 6	2,102	60	3	10,950	30	3,285.00
Lower end of Kissimmee Canal	No. 7	1,720	60	3	6,153	30	1,845.90
Total							11,184.90

Estimate for improvement of waterway between the town of Kissimmee an Lake Tohopekaliga and Bassinger Landing on Kissimmee River—Continued.

BULKHEADS.

Place.	Length.	Character.	Cost.
	Feet.		
East side Southport Canal, upper entrance.	514	Row of 6-inch piling, driven close together. Waling strips on both sides at height of 3 and 6 feet above ordinary stage of water.	$850.00
West side of Southport Canal, upper entrance.	656	.....do	1,005.00
West side and about midway between ends of Southport Canal.	2,960	Posts 5 inches diameter, and cap timbers 4 by 4 inch, with 2 by 8 inch sheet piling spiked to cap timbers. Two lines 25 feet apart.	5,920.00
East side and near lower end of Southport Canal.	400	Single line of sheet piling bulkhead, spiked to cap timbers on posts driven 6 feet apart.	460.00
Total			8,235.00

Dredging	$11,184.90
Building bulkheads	8,235.00
Engineering and contingencies	2,900.00
Total cost of improvement	22,319.90

Estimate for improvement of Istokpoga Creek, the western tributary of Kissimmee River.

DREDGING.

There are four shoals of small area in this stream. The one farthest downstream is 96 feet long; the next, 54 feet; the third, 52 feet; and the last, 50 feet. Width of the proposed sections is 25 feet, and depth, 3 feet. Total material to be removed is 332 cubic yards which, at $1.50 per yard, will cost $498.

SNAGS AND OVERHANGING TREES.

Blasting and hoisting out 50 snags, at $5 each	$250
Trimming 602 overhanging trees, at $1.50 each	903
Total	1,153

Dredging	498
Removal of snags and overhanging trees	1,153
Engineering and contingencies	250
Total cost of improvement	1,901

The dredging estimates are based on place measurements. One foot is allowed for backfilling. A slope of 1 on 3 is allowed for both sides of the cuts in Southport and Kissimmee canals. No slope is allowed for the cuts in Istokpoga Creek, because the estimates are based upon dredging to full width of the stream.

The unit price of dredging in Istokpoga Creek is estimated considerably larger than for the canals on account of the small quantity to be dredged and time required to tow a dredge to and from the scene of the work.

Very respectfully,

W. H. Caldwell,
Assistant Engineer.

Capt. Herbert Deakyne,
Corps of Engineers, U. S. Army.

APPENDIX R.

IMPROVEMENT OF RIVERS AND HARBORS IN WESTERN GEORGIA AND FLORIDA AND IN EASTERN ALABAMA.

REPORT OF FIRST LIEUT. R. R. RAYMOND, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Carrabelle Bar and Harbor, Florida.
2. Apalachicola Bay, Florida.
3. Apalachicola River, the Cut-off, and Lower Chipola River, Florida.
4. Upper Chipola River, Florida, from Marianna to its mouth.
5. Flint River, Georgia.
6. Chattahoochee River, Georgia and Alabama.
7. Choctawatchee River, Florida and Alabama.
8. Lagrange Bayou, Florida, including Holmes River, Florida, from Vernon to its mouth.
9. Pensacola Harbor, Florida.
10. Escambia and Conecuh rivers, Florida and Alabama.
11. Alabama River, Alabama.
12. Coosa River, Georgia and Alabama.
13. Operating and care of canals and other works of navigation on Coosa River, Georgia and Alabama.
14. Removing sunken vessels or craft obstructing or endangering navigation.

UNITED STATES ENGINEER OFFICE,
Montgomery, Ala., July 21, 1902.

GENERAL: I have the honor to forward herewith annual reports of the river and harbor works under my charge * * * for the fiscal year ending June 30, 1902.

* * * * * * *

Very respectfully, your obedient servant,

R. R. RAYMOND,
First Lieutenant, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

R 1.

IMPROVEMENT OF CARRABELLE BAR AND HARBOR, FLORIDA.

A description of the locality, its original condition, the project for improvement, the recommendations resulting from recent examinations and surveys, and the present condition of the channel across the bar at the river mouth are stated in the Annual Report of the Chief of Engineers for 1902, page 282.

Work done prior to June 30, 1900, will be found described upon pages 2088-2089, Annual Report of the Chief of Engineers for 1900.

No work has been done in the past fiscal year, no funds being available.

The river and harbor act approved June 13, 1902, appropriated the sum of $20,000 for improving East Pass, Carrabelle Harbor, Florida, to be expended in accordance with report submitted in House Doc. No. 63, Fifty-sixth Congress, first session. This report provides for an approved project for a channel 20½ feet deep and 150 feet wide across East Pass at the entrance of Carrabelle Harbor, Florida, and the closing of an opening in Dog Island.

RECOMMENDATIONS AND ESTIMATES.

The work upon the bar at the river mouth is important, but less immediately so than the deepening of East Pass, for if the latter channel be deepened 3 to 4 feet a more economical class of vessels will be admitted to the Carrabelle trade, with a great saving in freights and insurance. Until East Pass is improved no large appropriation will be recommended for the bar at the river mouth, and the work there contemplated will be to maintain 7 to 8 foot depths in the existing channel rather than to improve the same.

Money statement.

July 1, 1901, balance unexpended	$91.35
Amount appropriated by river and harbor act approved June 13, 1902	20,000.00
	20,091.35
June 30, 1902, amount expended during fiscal year	91.35
July 1, 1902, balance unexpended	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	10,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

June 3, 1896	$10,000.00
March 3, 1899	10,000.00
June 6, 1900 (allotment)	1,704.08
June 13, 1902	20,000.00
Total	41,704.08

COMMERCIAL STATISTICS.

The following information has been obtained from the collector of customs, port of Carrabelle, Fla.:

Exports to foreign ports	$234,837.33
Exports to coastwise ports	264,951.79
Total amount of exports	499,789.12

	Number.	Tons.
Vessels entered from—		
Foreign ports	48	24,858
Coastwise ports	17	8,775
Total	65	33,633
Vessels cleared for—		
Foreign ports	28	18,669
Coastwise ports	30	14,904
Steam vessels employed in traffic of the port	6	483

Amount of fees and dues paid to custom-house for Carrabelle, Fla., during fiscal year ending June 30, 1902, $1,402.53.

Freight carried.

Articles.		Quantity.	Value.
Lumber	feet B. M.	17,000,000	$232,817.19
Rosin	barrels	67,691	179,324.93
Spirits	gallons	192,993	87,847.00
Total value			499,789.12

R 2.

IMPROVEMENT OF APALACHICOLA BAY, FLORIDA.

A description of this locality, its original and present conditions, and the project for improvement are given in the Annual Report of the Chief of Engineers for 1902, page 283.

Work done prior to June 30, 1900, is described on pages 2092–2093, Annual Report of the Chief of Engineers for 1900.

No work was done during the past fiscal year, as no funds were available.

RECOMMENDATIONS AND ESTIMATES.

The importance of a deep-water harbor in this vicinity can not be overestimated.

Between Pensacola and Tampa, Fla., is an interval of about 380 miles, and the only deep-water harbor now projected between these ports is at Apalachicola, which is distant about 230 miles from Tampa and 150 miles from Pensacola. Such an interval between ports as 380 miles is perhaps unequaled upon the Atlantic coast or elsewhere upon the Gulf coast, except upon the lower peninsula of Florida. Moreover, a great system of navigable rivers has its mouth at Apalachicola Bay.

The channel across the bar at the river mouth should be maintained at a 9-foot minimum depth. That across the sea bar (West Pass) and the Link channel, separating the best part of the protected anchorage from the West Pass channel, should be dredged to 18 feet and then maintained. It is estimated that work on the bar at the mouth of the river will cost 20 cents per cubic yard, while that upon the sea bar and Link channel will cost 30 cents per cubic yard.

Estimate for the work recommended is as follows:

To maintain a 9-foot depth across the bar at the mouth of the river	$15,000
To dredge a channel to a depth of 18 feet across the bar at West Pass and Link channel	25,000
To maintain channel across West Pass	15,000
Total	55,000

The amount, $55,000, mentioned in above estimate can be profitably expended during the fiscal year ending June 30, 1904.

Money statement.

July 1, 1901, balance unexpended		$130.32
Amount appropriated by river and harbor act approved June 13, 1902		40,000.00
		40,130.32
June 30, 1902, amount expended during fiscal year		130.32
July 1, 1902, balance unexpended		40,000.00
Amount (estimated) required for completion of existing project		$290,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$25,000.00	
For maintenance of improvement	30,000.00	
		55.000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

March 2, 1833	$8,700	
July 4, 1836	10,000	
March 3, 1839	9,900	
		$28,600
July 14, 1880	10,000	
March 3, 1881	10,000	
August 2, 1882	25,000	
July 5, 1884	10,000	
August 5, 1886	12,000	
August 11, 1888	20,000	
September 19, 1890	20,000	
July 13, 1892	20,000	
August 18, 1894	15,000	
June 3, 1896	12,000	
March 3, 1899	20,000	
June 13, 1902	40,000	
		214,000
Total		242,600

COMMERCIAL STATISTICS FOR PORT OF APALACHICOLA, FLA., FROM JULY 1, 1901, TO JUNE 30, 1902.

Exports to foreign ports	$271,837
Exports to coastwise ports	519,732
Total	791,569
Imports from foreign ports	135
Duties on imports and miscellaneous collections	189

	Number.	Tons.
Vessels entered from—		
Foreign ports	51	32,753
Coastwise ports	38	18,638
Total	89	51,391
Vessels cleared for—		
Foreign ports	39	21,063
Domestic ports	58	30,570
Total	97	51,633
Vessels arriving which do not enter or clear at custom-house (estimated)	300	303,000
Vessels departing which do not enter or clear at custom-house	300	303,000
Total	600	606,000
Steam vessels employed in traffic of port	24	1,424
Sail vessels employed in traffic of port	16	130
Total	40	1,554

Amount of fees and dues paid to custom-house during fiscal year ending June 30, 1902, $1,820.

Freight carried.

Articles.		Quantity.	Value.
Lumber	feet B. M.	35,789,000	$622,305
Rosin	barrels	66,900	97,898
Spirits	gallons	189,437	71,366
Total		....	791,569

R 3.

IMPROVEMENT OF APALACHICOLA RIVER, THE CUT-OFF, AND LOWER CHIPOLA RIVER, FLORIDA.

Description of this river, statement of project for its improvement, and facts concerning its original and present conditions are given in Annual Report of the Chief of Engineers for 1902, p. 284.

A complete synopsis of work done upon the river from January 1, 1875, to June 30, 1895, may be found in Annual Report of the Chief of Engineers for 1896, pp. 1348–1350. Work from June 30, 1895, to June 30, 1901, is described in Annual Reports of the Chief of Engineers for 1900, pp. 2096–2097, and for 1901, pp. 1769–1771.

Work was suspended on October 11, 1900, for want of funds, and no work has been done since that date.

RECOMMENDATIONS AND ESTIMATES.

The Apalachicola River proper requires nothing but the removal of snags, which annually accumulate.

The Cut-off and Lower Chipola will require snagging, removal of overhanging timber, and widening in places, especially at sharp turns, by dredging.

Estimate for the above work is as follows:

For widening at sharp turns in the Cut-off and Lower Chipola River	$5,000
For snagging and removing overhanging timber	5,000
Total	10,000

which amount can be profitably expended during the fiscal year ending June 30, 1904.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902		$6,000.00
July 1, 1902, balance unexpended		6,000.00
Amount (estimated) required for completion of existing project		15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$5,000.00	
For maintenance of improvement	5,000.00	
		10,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

May 23, 1828	$3,000	August 11, 1888	2,000
April 23, 1830	2,000	September 19, 1890	2,000
March 2, 1831	8,000	July 13, 1892	5,000
June 23, 1874	10,000	August 18, 1894	5,000
March 3, 1875	10,000	June 3, 1896	5,000
June 18, 1878	8,000	March 3, 1899	3,000
March 3, 1879	5,000	June 6, 1900 (allotment from emergency act)	1,500
June 14, 1880	2,000	June 13, 1902	6,000
March 3, 1881	1,500		
August 2, 1882	2,000	Total	83,000
July 5, 1884	1,000		
August 5, 1886	1,000		

COMMERCIAL STATISTICS.

The commerce interested on this river is chiefly cotton, naval stores, and general merchandise. This river runs through a section of country where there are but few railroads, and the people depend largely on the boats for their supplies. There is also a large passenger traffic on this river.

* * * Reference is made to the Flint River report for figures.

R 4.

IMPROVEMENT OF UPPER CHIPOLA RIVER, FLORIDA, FROM MARIANNA TO ITS MOUTH.

Description of this river and statements of its past and present conditions and of the project are given in the Annual Report of the Chief of Engineers for 1902, page 285.

The work done is described on pages 2099-2100, Annual Report of the Chief of Engineers for 1900.

No work was done during the past fiscal year on account of lack of funds.

RECOMMENDATIONS AND ESTIMATES.

It is recommended that no further work upon this waterway be undertaken beyond the removal of snags, stumps, logs, and overhanging trees between Sister Islands and the foot of the Dead Lakes to the Lower Chipola River. Included in the work to be done should be the dredging of a channel through the mud bar at Sister Islands. This will open up a waterway from the Apalachicola River system to "Look and Tremble" shoals, about 45 miles below Marianna. To go farther would involve the construction of at least one lock and dam and very expensive channel work over rock shoals. As the river has already been cleaned of snags above "Look and Tremble," in high stages barges can bring down freight from Marianna to the shoal and then transfer it.

Estimate for the work recommended is as follows:

To clean channel through the Dead Lakes and up to Sister Islands	$7,000
Dredging channel at Sister Islands	1,500
Total	8,500

This amount can be profitably expended during the fiscal year ending June 30, 1904.

After the accomplishment of the work estimated for above, that part of the river below "Look and Tremble" shoals should be maintained free of snags, etc., and such might well be combined with similar operations upon the entire Apalachicola River system, as a plant is already possessed by the United States for this purpose.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902	$2,000.00
July 1, 1902, balance unexpended	2,000.00
Amount (estimated) required for completion of existing project	34,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	8,500.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

APPROPRIATIONS.

March 3, 1899	$5,000
June 13, 1902	2,000
Total	7,000

COMMERCIAL STATISTICS.

Statement of business done during past fiscal year on the Upper Chipola, Florida.

Name and description.	Registered tonnage.	Draft.	
		Light.	Loaded.
		Feet.	*Feet.*
Little Belle (tug and 2 barges)	2	3	3½

Freight carried.

Articles.	Quantity.	Tons.
Fertilizers .... sacks..	900	90
Grain .... do....	11,000	500
Hay .... bales..	950	95
Rosin .... barrels..	17,000	3,400
Flour .... do....	1,200	120
General miscellaneous .... packages..	16,000	2,665
Provisions .... do....	8,000	400
Shingles .... number..	80,000	40
Brick .... do....	7,000	14
Total	....	7,324

Estimated value of above freight in round numbers, $402,820.

Large quantities of pine and cypress timber are rafted down this stream, the value of which is not known, but it is included in the valuation of timber for Apalachicola and Carrabelle.

R 5.

IMPROVEMENT OF FLINT RIVER, GEORGIA.

For previous history, statements of project, and present conditions, see Annual Report of the Chief of Engineers for 1902, page 285.

For a detailed account of past operations, see Annual Reports of the Chief of Engineers for 1900, pages 2102–2103; 1901, pages, 1773–1775.

No work has been done during the past fiscal year, as no funds were available.

RECOMMENDATIONS AND ESTIMATES.

It is recommended that work hereafter be confined to the sections below Albany, connecting the two navigable sections by completing the improvement of the portion between Newton and Bainbridge, removing isolated bowlders below the latter point, and snagging the river whenever necessary by way of maintenance. Notwithstanding the fact that a small dipper dredge has been built for use upon the Chattahoochee, Flint, and Apalachicola rivers, it is believed that for an economical prosecution of work a second dredge of about the same capacity (1½ cubic yard dipper) should be built, at a cost of about $16,000, for use upon Flint River alone. In no other way than by dredging can the débris from blasting rock bars be economically removed. The dredge now on hand will be needed for several years upon the Chattahoochee exclusively.

Estimate for the work recommended is as follows:

For removing bowlders below Bainbridge	$4,000
For a dredge	16,000
For channel work between Bainbridge and Newton	15,000
For maintenance (snagging, etc.)	5,000
Total	40,000

This amount can be profitably and advantageously expended during fiscal year ending June 30, 1904.

Money statement.

July 1, 1901, balance unexpended		$570.66
Amount appropriated by river and harbor act, approved June 13, 1902		25,000.00
		25,570.66
June 30, 1902, amount expended during fiscal year		430.15
July 1, 1902, balance unexpended		25,140.51
July 1, 1902, outstanding liabilities		5.94
July 1, 1902, balance available		25,134.57
Amount (estimated) required for completion of existing project		92,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$35,000.00	
For maintenance of improvement	5,000.00	
		40,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

June 23, 1874 March 3, 1875 August 14, 1876	[a]$18,000	August 11, 1888	$20,000
June 18, 1878	10,000	September 19, 1890	20,000
March 3, 1879	7,000	July 13, 1892	15,000
June 14, 1880	20,000	August 18, 1894	8,000
March 3, 1881	15,000	June 3, 1896	8,000
August 2, 1882	25,000	March 3, 1899	5,000
July 5, 1884	20,000	June 13, 1902	25,000
August 5, 1886	20,000	Total	236,000

COMMERCIAL STATISTICS.

The commerce of this stream is principally cotton, naval stores, and lumber. There are great quantities of fine timber along the banks of the river, mainly pine, cypress, and hard wood.

When the river is made navigable from Albany to Bainbridge the entire year it will greatly benefit these industries, and new ones will spring up along the river.

For the Flint River alone the following statistics have been received:

Stern-wheel steamboats.	Registered tonnage.	Draft, light.	Round trips.
		Inches.	
J. P. Williams	61	22	144
Bessie Clary	43	14	80

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[a] Allotted from appropriations aggregating $70,000 for improving Chattahoochee and Flint rivers.

Freight carried.

Articles.		Quantity.	Tons.
Cotton	bales	4,600	1,150
Cotton seed	sacks	1,200	67
Cotton-seed meal	do	1,400	70
Fertilizers	do	5,000	500
Oats	do	2,800	233
Corn	do	3,800	317
Hay	bales	4,500	225
Rosin	barrels	45,000	11,250
Turpentine	do	12,000	2,400
Flour	do	1,860	186
Sugar	do	160	26
Molasses	do	20	2
Bagging	rolls	1,200	60
Ties	bundles	800	26
General miscellaneous	packages	300	10
Lumber	feet	100,000	200
Provisions	packages	6,000	300
Shingles	number	100,000	50
Brick	do	120,000	240
Total		....	17,312

Estimated value of above freights in round numbers is $865,000.

The quantities above refer to that section of the river between Albany, Ga., and Bainbridge, Ga.

Between Bainbridge and the mouth of the river the stream is used by the steamers plying the Chattahoochee and Apalachicola rivers, and for the commerce of this entire system reference is made to the following table:

Stern-wheel steamboats.	Registered tonnage.	Draft.		Round trips.	Passengers.
		Light.	Loaded.		
		Inches.	*Inches.*		
M. W. Kelly	95	18	48	[a] 44	3,744
Queen City	150	24	48	[a] 61	6,772
W. C. Bradley	175	20	48	[a] 54	6,067
J. W. Hires	125	20	48	[a] 25	1,390
Three States	126	18	48	[a] 20	1,122
Naiad	173	20	48	[b] 101	5,684
Eunola	80	20	28	[c] 2	....

[a] Between Columbus, Ga., and Apalachicola, Fla.
[b] Between Chattahoochee and Apalachicola, Fla.
[c] Weekly between Alaga, Ala., and Cochrans Landing, Fla., since May 1

Freight carried.

Articles.		Quantity.	Tons.
Cotton	bales	13,553	2,710
Cotton seed	sacks	40,664	3,128
Cotton-seed meal	do	6,587	329
Fertilizers	do	38,910	3,891
Grain	do	31,380	2,615
Resin	barrels	59,480	14,870
Turpentine	do	17,511	4,377
Molasses	do	6,000	1,200
General miscellaneous	packages	318,290	53,048
Hides and skins	do	80	13
Live stock	head	456	228
Lumber	feet	450,000	900
Staves	pieces	17,000	170
Provisions	packages	235,235	23,523
Shingles	number	16,483,000	8,241
Brick	do	598,000	1,495
Total		....	120,738

The estimated value of the above freight in round numbers is $11,500,000.

In addition to the above, large quantities of timber are carried down these streams to sawmills near Apalachicola Bay, of which no value is given, as there seems to be some difficulty in keeping a record of the amount of timber rafted down, but its value is included in the general value of the commerce reported for Apalachicola Bay, Florida.

R 6.

IMPROVEMENT OF CHATTAHOOCHEE RIVER, GEORGIA AND ALABAMA.

GENERAL IMPROVEMENT.

For descriptions and statements of project see Annual Report of the Chief of Engineers for 1902, page 286. For detailed statements of past operations see Annual Reports of the Chief of Engineers as follows: 1898, pages 1388–1390; 1900, pages 2107–2108; 1901, pages 1775–1777.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1902.

A dipper dredge of 1½ cubic yards capacity, built by the M. A. Sweeney Ship Yard and Foundry Company of Jeffersonville, Ind., was completed and delivered in the month of August, 1901.

Dredging was done at "Tumbling Spring" and Abercrombie's bar; jetties repaired at St. Francis bend, and the snagboat worked over the entire river from Columbus, Ga., to Chattahoochee, Fla. The following was accomplished during the working season:

SUMMARY.

Overhanging trees removed		815
Overhanging trees trimmed		41
Stumps on banks cut level		44
Snags removed from river		150
Bushes cut on banks		109
Logs on banks removed		39
Marl excavated	cubic yards	120
Gravel and sand excavated	do	655

RECOMMENDATIONS AND ESTIMATES.

The following work is of immediate importance: The old works on the improvement should be repaired; in a great many places the rock and gravel filling has completely washed out of the pile jetties. In several places, where the river has excessive width, contraction works should be built. The rock reefs should be blasted at King's Rock and Rock Island.

The bar immediately below Columbus, Gunboat shoal, Shell Creek bar, and St. Francis bend are other locations requiring attention. Among the articles of plant that must be provided for an economical prosecution of the work, it is recommended that a suction dredge for working upon sand and gravel bars, a pile-driver barge, two rock barges, and two dump scows, all of which are badly needed, be built as soon as possible. During high water in the river the dredge could be economically employed upon the river mouth bars at Carrabelle and Apalachicola.

At all times the river should be maintained clear of snags, etc.

ESTIMATE.

Repairing old works, jetties, and dams	$5,000
Building new works of contraction	10,000
Removing annual accumulation of snags (for two years)	20,000
Dredging between Columbus, Ga., and Eufaula, Ala	10,000
Building additional plant, viz: Suction dredge, $8,000; pile-driver barge, $5,000; rock barges, $3,000, and dump scows, $4,000	20,000
Taking care of property, and repairs to same	5,000
Total	70,000

This amount can be profitably and advantageously expended during the fiscal year ending June 30, 1904.

Money statement.

July 1, 1901, balance unexpended, general improvement	$18,210.85
July 1, 1901, balance unexpended between West Point and Franklin	280.78
	18,491.63
Amount appropriated by river and harbor act approved June 13, 1902	100,000.00
	118,491.63
June 30, 1902, amount expended during fiscal year	15,747.68
July 1, 1902, balance unexpended	102,743.95
July 1, 1902, outstanding liabilities	470.90
July 1, 1902, balance available	102,273.05

Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$40,000.00	
For maintenance of improvement	30,000.00	
		70,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

February 24, 1835	$2,000.00
June 23, 1874 March 3, 1875 August 14, 1876	[a] 52,000.00
June 18, 1878	18,000.00
March 3, 1879	15,000.00
June 4, 1880	20,000.00
March 3, 1881	20,000.00
August 2, 1882	25,000.00
July 5, 1884	35,000.00
August 5, 1886	20,000.00
August 11, 1888	20,000.00
September 19, 1890	20,000.00
July 13, 1892	$20,000.00
August 18, 1894	[b] 25,000.00
June 3, 1896	[b] 20,000.00
March 3, 1899	[b] 45,000.00
June 13, 1902	100,000.00
Amount of unexpended balance transferred from appropriation for Chattahoochee River between West Point and Franklin	280.78
Total	[c] 457,280.78

COMMERCIAL STATISTICS.

The commerce interested on this river is chiefly cotton, naval stores, and general merchandise. The river runs through a section of country where there are but few railroads (none parallel with the river), and the people depend largely on the boats for their supplies. There is also a large passenger traffic on this river.

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[a] Allotted from appropriations aggregating $70,000 for improving Chattahoochee and Flint rivers.

[b] Does not include $5,000 allotted for expenditure between West Point and Franklin.

[c] Of this amount $2,000 (appropriation of February 24, 1835) was carried to the surplus fund.

The commercial statistics for the Chattahoochee River are so combined with those of the Flint and Apalachicola rivers that a separation is impossible, and reference is made to report upon Flint River improvement for figures.

Columbus, Ga., at the head of navigation, with its magnificent water powers, is rapidly becoming one of the greatest manufacturing centers of the South. At the mouth of this system of rivers a deep-water harbor is projected.

R 7.

IMPROVEMENT OF CHOCTAWHATCHEE RIVER, FLORIDA AND ALABAMA.

For description, statements of project, and original and present conditions, see Annual Report of the Chief of Engineers for 1902, page 287.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1902.

No work of improvement was done on this river during the past fiscal year.

On December 10, 1900, the old snag boat used on this river struck an obstruction and sank. A new hull was built during the present fical year, but a new boiler, machinery, and wheel will have to be installed to put the boat in a working condition.

RECOMMENDATIONS AND ESTIMATES.

Both Geneva and Newton are now touched by railroads, and the river between crossed by one, thus taking away from the river the little commerce that formerly made use of this part of the river for transportation. The improvement of this part of the stream and its maintenance would be expensive, as the channel is narrow, crooked, and shoal, and the banks caving, throwing a large number of trees into it. It is recommended that no further work be done on this section after the funds hitherto appropriated have been expended.

Below Geneva the river should be kept free of snags to enable rafts of logs and timber to be floated down, and the bar at the mouth of the river (Cypress Top) should be kept dredged to a least depth of 5 feet to enable tugs to enter the river to secure and make up their tows of timber and logs.

The sum of $8,000, for maintenance, can be profitably and advantageously expended during the fiscal year ending June 30, 1904.

Money statement.

July 1, 1901, balance unexpended	$1,786.87
Amount appropriated by river and harbor act approved June 13, 1902	16,000.00
	17,786.87
June 30, 1902, amount expended during fiscal year	1,563.64
July 1, 1902, balance unexpended	16,223.23
July 1, 1902, outstanding liabilities	49.50
July 1, 1902, balance available	16,173.73
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	8,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

March 3, 1833	$5,000.00	September 19, 1890	$12,500.00
June 15, 1844	10,000.00	July 13, 1892	12,500.00
June 25, 1874	5,000.00	August 18, 1894	6,000.00
March 3, 1875	5,000.00	June 3, 1896	5,000.00
August 4, 1876	5,000.00	March 3, 1899	16,000.00
March 3, 1879	5,000.00	June 13, 1902	16,000.00
June 14, 1880	7,000.00		
March 3, 1881	10,000.00	Total	178,000.00
August 2, 1882	[a] 18,000.00	Carried to the surplus fund, 1852	2,123.38
July 5, 1884	15,000.00		
August 5, 1886	15,000.00		
August 11, 1888	10,000.00	Balance	175,876.62

COMMERCIAL STATISTICS.

Statement of business done by the steamboats plying the Choctawhatchee River, Florida and Alabama.

[Compiled from statements made by the owners of the same, and parties interested.]

Stern-wheel steamboats.	Registered tonnage.	Draft of water.		Round trips.	Between—
		Light.	Loaded.		
		Inches.	*Inches.*		
Vernon	61	24	42	37	Pensacola, Fla., and Parish Landing on Holmes River, via Choctawhatchee River, Fla.
Capitola	60	11	30	2	Weekly, between Geneva, Ala., and Caryville, Fla.
Forest	59	10	24	2	Do.

Freight carried.

Articles.		Quantity.	Tons.
Cotton	bales	68	17
Cotton-seed hulls	do	1,604	64
Cotton-seed meal	sacks	189	9
Fertilizers	do	1,720	172
Oats	do	1,085	90
Corn	do	2,926	244
Hay	bales	1,347	67
Wool	do	34	3
Rosin	barrels	18,368	4,592
Turpentine	do	11,654	2,913
Flour	do	1,101	110
Sugar	do	50	7
Molasses	do	16	4
General miscellaneous	packages	12,096	2,016
Lumber	feet	3,650	7
Provisions—case goods	packages	873	43
Coffee	sacks	117	9
Corn meal	do	1,030	70
Bacon, smoked and dry salted	boxes	129	61
Salt	sacks	226	22
Lard	packages	124	15
Soap	boxes	45	2
Nails	kegs	88	4
Brick	number	1,600	8
Total			10,544

Estimated value of the above freight in round numbers, $529,000.

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[a] Does not include $2,000 allotted for expenditure on Holmes River.

R 8.

IMPROVEMENT OF LAGRANGE BAYOU, FLORIDA, INCLUDING HOLMES RIVER, FLORIDA, FROM VERNON TO ITS MOUTH.

For descriptive statement of conditions and project, see Annual Report of the Chief of Engineers for 1902, page 288.

No work was done during the past fiscal year.

RECOMMENDATIONS AND ESTIMATES.

The balance unexpended is available for maintenance of the improvement. No additional appropriation will be needed for several years.

Money statement.

July 1, 1901, balance unexpended	$2,220.20
June 30, 1902, amount expended during fiscal year	150.00
July 1, 1902, balance unexpended	2,070.20

APPROPRIATIONS.

August 2, 1882	[a]$2,000
August 5, 1886	2,000
August 11, 1888	3,000
September 19, 1890	3,000
Total	[b]10,000

R 9.

IMPROVEMENT OF PENSACOLA HARBOR, FLORIDA.

For past and present conditions, projects, and summary of work done see Annual Report of the Chief of Engineers for 1902, page 288.

Pensacola Harbor possesses 7 square miles of landlocked anchorage area, with depth exceeding 30 feet. Considering all natural advantages, it is not excelled by any harbor in the United States south of Hampton Roads.

CONDITION OF CHANNEL AT BEGINNING OF FISCAL YEAR.

At the intersection of the McRee with the Caucus ranges, a shoal spot about 100 feet in length and extending across the channel had a least depth of 29.3 feet at mean low water. All other soundings on the center line of the Caucus channel showed 30 feet and more. This least channel depth, viz, 29.3 feet, was reduced to 27.5 feet between February 12, 1901, and June 30, 1901, this shoal spot still being on the intersection referred to. Therefore the available depth at the beginning of the fiscal year now ending was 27.5 feet at mean low water.

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[a] Allotted from appropriation of $20,000 for improving Choctawhatchee River.

[b] Of this amount there was returned to the Treasury $4,839.20, which was reappropriated by act of March 3, 1899.

WORK PERFORMED DURING THE FISCAL YEAR ENDING JUNE 30, 1902.

The shoaling of the channel at and north of the intersection of the McRee and Caucus ranges continued until early in the fiscal year the available depth was reduced to 27.3 feet, and toward the outer end the shoaling from the east (evidently due to storm action) narrowed the channel. The depth of 30 feet at this point, however, was maintained.

Advantage was taken of the suspension of work on the Galveston Harbor improvement, and the U. S. dredge *Comstock* was secured to restore the 30 feet depth and to widen the channel at the narrow points. The *Comstock* reported for work on February 16, 1902; on the following day the work of connecting suction pipes was started, but this had to be abandoned from day to day owing to the very stormy weather, and the work of dredging was therefore not commenced until February 25, 1902. During the entire month of March the weather was stormy and the sea rough, only twelve full working days being secured. From April 1, 1902, until the close of the work, June 12, 1902, weather conditions were more favorable and excellent progress was made. Work was confined to shoal spots and to the narrow localities. The total number of cubic yards removed was 184,753.8, at a cost of $0.0605 per cubic yard. This cost includes all expenses from the time the *Comstock* began fitting up for her trip to Pensacola until she was transferred back to the Galveston district.

The work done by the *Comstock* restores the 30-foot depth at mean low water throughout the center of the channel for a width of about 100 feet, but the widening done leaves a channel of at least 200 feet in width, with a depth of 28 feet at mean low water.

As a vessel can not carry the greater channel depth, owing to her rising and falling with the swell, 28 feet at mean low water is the draft that can be safely carried through the channel at the close of the fiscal year.

RECOMMENDATIONS AND ESTIMATES.

Dredging by contract upon Caucus shoal can not be done for less than 15 cents per cubic yard. With a suitable Government plant this cost can be cut in two, provided the plant be continuously employed. By far the most economical way to secure and maintain deep water at Pensacola is through the use of such a plant, and incidentally there could be accomplished the improvement and maintenance of other harbors on the Gulf coast while the plant is not employed on the harbor at Pensacola, Fla.

The building of a dredge may require a year's time. This has been the stumbling-block in the past and the cause of making contracts.

To secure a channel across the Caucus shoal having 30 feet depth at mean low water and a width of 500 feet, as provided for in the act of June 13, 1902, will necessitate the removal of 1,783,740 cubic yards of material. This includes the fill for one year during the construction of the dredge provided for in the said act and for the fill during three years of continuous dredging of days of twelve hours each.

In order that some gain may be made upon the fill going on during the year that the dredge will be under construction, $70,000 of the amount provided for in the river and harbor bill of June 13, 1902, may be used in dredging by contract, which, at an estimated cost of 15 cents per cubic yard, will remove about 467,000 cubic yards, leaving 1,316,740 cubic yards to be removed by the dredge provided for in the bill. This, estimated at 8 cents per cubic yard, will amount to $105,339.

ESTIMATE.

For operating dredge to be built (2 years)	$105,339

This amount can be economically and advantageously expended during the fiscal year ending June 30, 1904.

REMARKS.

Under the project of 1899 no work has been done as yet on the city front.

To make an estimate for this project it is necessary to fix definitely the limits within which the 30-foot depth shall be secured.

It is thought that the following limits will cover the project as contemplated by Congress in the act of March 3, 1899, viz: An area bounded by the 30-foot curve in the harbor, the established pierhead line, a line drawn from the 30-foot curve to the pierhead line, parallel to the Perdido wharf, intersecting the pierhead line 200 feet west of the intersection of this line by the wharf produced, and a line from the 30-foot curve to the pierhead line, parallel to the channel dredged to the Muscogee wharf, and intersecting the pierhead line 200 feet east of the intersection of this line by the wharf produced. The amount of dredging necessary within this area is estimated at 4,985,000 cubic yards.

The building of the bulkhead on the approved line will have an important bearing upon the work to be done in the harbor front of the city of Pensacola, as the construction of this bulkhead will determine the manner in which a greater portion of the work is to be done and solve the problem of the disposition to be made of a large quantity of the dredged material. It is recommended that nothing be done in this locality until the urgently needed work upon the channel across the Caucus shoal be accomplished.

Money statement.

July 1, 1901, balance unexpended		$12,532.59
Amount appropriated by river and harbor act approved June 13, 1902	$220,000	
Amount allotted from emergency river and harbor act of June 6, 1900	5,000	
		225,000.00
		237,532.59
June 30, 1902, amount expended during fiscal year		13,870.80
July 1, 1902, balance unexpended		223,661.79
July 1, 1902, outstanding liabilities		2,428.96
July 1, 1902, balance available		221,232.83
Amount (estimated) required for completion of existing project		608,200.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902		105,339.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

APPROPRIATIONS.

June 18, 1878	$20,000	July 13, 1892	$75,000
March 3, 1879	10,000	August 18, 1894	100,000
June 14, 1880	40,000	June 3, 1896	200,000
March 3, 1881	20,000	March 3, 1899	70,000
August 2, 1882	50,000	June 6, 1900 (allotment)	5,000
July 5, 1884	55,000	June 13, 1902	220,000
August 5, 1886	20,000		
August 11, 1888	35,000	Total	945,000
September 19, 1890	25,000		

COMMERCIAL STATISTICS.

The following information has been obtained from the collector of customs, port of Pensacola, Fla.:

Exports to foreign ports	$14,464,171.00
Exports to coastwise ports	1,000,000.00
Total amount of exports	15,464,171.00
Imports from foreign ports	142,922.00
Duties on imports and miscellaneous collections	81,129.76

	Number.	Tons.
Vessels entering from—		
Foreign ports	343	435,806
Coastwise ports	174	208,667
Total	517	644,473
Vessels cleared for—		
Foreign ports	413	540,878
Domestic ports	124	94,409
Total	537	635,287
Number of vessels employed in traffic of port:		
Steam	33	4,059
Sail	122	9,034
Total	155	13,093

Amount of fees and dues paid to custom-house during fiscal year ending June 30, 1902, $22,238.27.

Freight carried.

Articles.	Quantity.	Value.
Cotton .... bales..	199,625	$8,069,329
Lumber .... feet B. M..	148,436,000	2,103,025
Coal .... tons..	164,717	379,084
Rosin .... barrels..	101,694	155,055
Spirits .... gallons..	966,991	362,701
Total	....	11,069,194

R 10.

IMPROVEMENT OF ESCAMBIA AND CONECUH RIVERS, FLORIDA AND ALABAMA.

For description of this waterway and statements of conditions and project, see Annual Report of the Chief of Engineers for 1902, page 290. The object of the improvement is to keep open a channel such as will insure the safe passage of rafts and logs during low stages, and this has been practically accomplished.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1902.

No work was done on this river during the last fiscal year.

RECOMMENDATIONS AND ESTIMATES.

It is recommended that the river during the low-water season be maintained free of snags, overhanging trees, and sunken obstructions, this being necessary to facilitate the movement of saw logs and timber rafts; that the bar at the mouth of the river be dredged to a depth of 8½ feet for a width of 100 feet, and marked with piling, to enable boats to pass out with tows of logs and timber.

ESTIMATE.

For maintenance as outlined above	$12,000

This amount can be profitably and advantageously expended during the fiscal year ending June 30, 1904.

Money statement.

July 1, 1901, balance unexpended	$59.01
Amount appropriated by river and harbor act approved June 13, 1902	5,000.00
	5,059.01
June 30, 1902, amount expended during fiscal year	59.01
July 1, 1902, balance unexpended	5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	12,000.00

APPROPRIATIONS.

For Escambia River:	
March 2, 1833	$5,000
July 2, 1836	5,500
June 14, 1880	8,000
March 3, 1881	5,000
July 5, 1884	3,000
For Escambia and Conecuh rivers:	
August 2, 1882	12,000
July 5, 1884	12,000
August 5, 1886	12,000
August 11, 1888	10,000
September 19, 1890	7,500
July 13, 1892	8,000
August 18, 1894	6,000
June 3, 1896	4,000
March 3, 1899	5,000
June 6, 1900 (allotted from emergency act)	1,500
June 13, 1902	5,000
Total	109,500
Carried to the surplus fund, 1838	5,500
Balance	104,000

R II.

IMPROVEMENT OF ALABAMA RIVER, ALABAMA.

For description, statements of past and present conditions, and project, see Annual Report of the Chief of Engineers for 1902, page 291. Previous operations upon this river will be found in annual reports of the Chief of Engineers, as follows: 1896, pages 1397 et seq.; 1898, pages 1406 et seq.; 1899, pages 1677 et seq.; 1900, pages 2133 et seq.; and 1901, pages 1786 et seq.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1902.

Owing to the excessive rainfall occurring during the usual period of low water, the river was at such a high stage that operations were for weeks at a time entirely suspended. Consequently very little work was accomplished. The snag boat continued at work whenever possible during the season, but was laid up during the early part of the month of November, 1901.

The following is a summary of work done:

Overhanging trees removed	572
Overhanging trees trimmed	36
Logs on banks cut up	5
Stumps on banks cut up	8
Stumps removed from the river	23
Snags removed from the river	105
Logs and trees removed from the river	43
Deadheads removed from the river	94
Piling removed from the river	6

No works of contraction for the permanent improvement of the river were built during the year, nor were any repairs made to those previously constructed.

During the present fiscal year the snag boat *Twining* and towboat *John Mills* were docked and put in good repair for the season's work.

Under contract with the M. A. Sweeney Shipyard and Foundry Company, of Jeffersonville, Ind., a dredge boat with dipper capacity of 1½ cubic yards was completed and towed up to Montgomery, Ala., and laid up.

RECOMMENDATIONS AND ESTIMATES.

It is recommended that snagging and dredging operations be continued; that some of the old works of contraction be repaired, and that such new works as may be found absolutely necessary be built. Silver Creek shoals, Gardners Island, and Lower Gause bar require attention. Some years ago the owner of the land dug a ditch across the point above the head of Taits shoal; the river has broken through at this point and caused a bad shoal to form just below the head of this "cut-off." This break should either be closed or cleared of all obstructions, so that steamers can make use of it during the low water periods.

ESTIMATES.

Repairing old works	$5,000.00
Building new works of contraction	20,000.00
Removing annual accumulation of snags from the channel (two years)	20,000.00
Dredging at some of the most important points	5,000.00
Taking care of plant and keeping same in repair	3,000.00
Total	53,000.00

This amount can be profitably and advantageously expended during the fiscal year ending June 30, 1904.

Money statement.

July 1, 1901, balance unexpended		$27,482.77
Amount appropriated by river and harbor act approved June 13, 1902		20,000.00
		47,482.77
June 30, 1902, amount expended during fiscal year		25,195.80
July 1, 1902, balance unexpended		22,286.97
July 1, 1902, outstanding liabilities		1,017.88
July 1, 1902, balance available		21,269.09
Amount (estimated) required for completion of existing project		176,251.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$20,000.00	
For maintenance of improvement	33,000.00	
		53,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

June 18, 1878	$25,000	September 19, 1890	$20,000
March 3, 1879	30,000	July 13, 1892	70,000
June 14, 1880	25,000	August 18, 1894	50,000
March 3, 1881	20,000	June 3, 1896	40,000
August 2, 1882	20,000	March 3, 1899	50,000
July 5, 1884	10,000	June 13, 1902	20,000
August 5, 1886	15,000		
August 11, 1888	20,000	Total	415,000

COMMERCIAL STATISTICS.

Statement of business done by steamboats plying the Alabama River, Alabam

[Compiled from statements made by owners of same and parties interested.]

Name and description.	Registered tonnage.	Draft of water.		Round trips.	Between—	Passengers.
		Light.	Loaded.			
		Inches.	*Feet.*			
City of Mobile	209	22	5	47	Mobile and Montgomery.	4,200
Nettie Quill	299	30	6	50	Mobile and Selma	
Mary	250	30	6		Mobile and Prairie Bluff.	
Tinsle Moore	198.29	30	5		Laid up	
Carrier	140.88	24	5		do	
Barge Tide	320	10	3		do	
Barge Wave	320	10	3		do	
Barge Nellie	320	10	3		do	
Barge Mary						

Freight carried.

Articles.		Quantity.	Tons.
Cotton	bales..	32,663	8,166
Cotton seed	sacks..	130,200	7,161
Cotton-seed meal	do....	44,900	2,245
Fertilizers	do....	89,800	8,980
Oats	do....	58,200	5,820
Corn	do....	82,220	6,167
Hay	bales..	16,100	805
Wool	do....	1,165	233
Rosin	barrels..	14,800	2,960
Turpentine	do....	11,600	2,610
Flour	do....	23,260	2,326
Sugar	do....	5,250	735
Molasses	do....	1,140	285
Bagging	rolls..	10,800	270
Ties	bundles..	16,280	208
General miscellaneous	packages..	95,400	9,540
Hides and skins	do....	715	143
Live stock	head..	2,900	483
Lumber	feet..	952,000	1,904
Staves	pieces..	861,000	8,610
Provisions (case goods)	packages..	79,900	4,395
Coffee	sacks..	2,500	208
Corn meal	barrels and sacks..	25,400	1,270
Bacon, smoked and dry salted	boxes..	13,400	2,233
Salt	sacks..	7,500	750
Lard	packages..	7,800	975
Soap	boxes..	9,700	485
Nails	kegs..	6,700	335
Shingles	M..	3,312,000	33,120
Brick	M..	268,000	670
Total		....	114,087

Estimated value of above freights (in round numbers)	$8,060,000
Estimated value of hewn, sawn, and round timber	3,500,000

Very large quantities of sawn and hewn timber, saw logs, cord wood, etc., consisting of yellow pine, sycamore, cottonwood, poplar, and ash, are barged and rafted down this stream to Mobile, Ala., but the amount of this business can not be accurately stated, as the statistics of the port of Mobile include the receipt of such articles as are received there from this stream as well as the Tombigbee and other streams tributary to that port.

R 12

IMPROVEMENT OF COOSA RIVER, GEORGIA AND ALABAMA.

For description of this river, and statements of past and present conditions, and project, see Annual Report of the Chief of Engineers for 1902, page 291.

1. BETWEEN ROME AND EAST TENNESSEE, VIRGINIA AND GEORGIA RAILROAD BRIDGE.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1902.

With the small balance available no new work of construction could be undertaken, and expenditures were confined to maintenance of existing structures and care of the large amount of plant on hand.

In addition to this, extensive repairs to Dam No. 4 were undertaken, and at the close of the year were very nearly completed; the cofferdam at Lock No. 4 was repaired, and a new hull was built for dredge boat. Details of this work are given in report of "Operating and care of canals," etc., Coosa River, Georgia and Alabama.

RECOMMENDATIONS AND ESTIMATES.

It is recommended that Lock No. 4 be completed, but it is believed that the lift of the lock and the height of the dam should be increased 3 feet in addition to the increase now being made, in order to give 6 feet of water at the head of "Box shoals" and for a distance of 10 miles above Lock 4, thereby greatly decreasing the amount of channel work necessary to give the above depth. The stability of the dam at Lock 4 when the repairs now being made are completed will be largely in excess of that required, and the increased height in the dam and lift of the lock can be made at a much less cost than the channel work necessary to give a good navigable channel.

It is also recommended that a dam without lock be built at the site proposed for Lock 5, the next lock in the series. If such were done, there would be continuous navigation for 191 miles below Rome, Ga., to a point 12 miles below Lock No. 4, through the four upper locks.

Repairs should be made to the steamer *Leota*, belonging to the improvement. The boat can hardly be kept afloat, as her hull is rotten and worn out. The propelling machinery is in good order. The repairs necessary will consist in building a new hull entire and transferring machinery and cabin to same. This boat is absolutely necessary in carrying on the work in progress and in contemplation, and should be kept in good condition all ready for work at all times, as it is the only means of transportation to be had when any work is in progress on the river proper or maintaining the locks now in operation.

The following is the estimate of funds required:

Completing Lock 4 (with height of dam and lift of lock increased 3 feet)	$292,000
Constructing dam at site of Lock 5	95,000
Continuing channel work between Rome, Ga., and Lock No. 4	20,000
Building hull for towboat *Loeta*	6,000
Total	413,000

This amount can be profitably and advantageously expended during the fiscal year ending June 30, 1904.

APPROPRIATIONS.

August 14, 1876	$30,000.00
June 18, 1877	75,000.00
March 3, 1879	45,000.00
July 14, 1880	75,000.00
March 5, 1881	60,000.00
August 2, 1882	83,700.00
July 5, 1884	50,000.00
August 5, 1886	45,000.00
August 11, 1888	60,000.00
September 19, 1890	150,000.00
July 13, 1892	130,000.00
August 18, 1894	$110,000.00
June 3, 1896	50,000.00
March 3, 1899	20,000.00
June 13, 1902	25,000.00
June 13, 1902, amount made available from lower division of river	10,000.00
Received from sales of property	1,322.40
Total	1,020,022.40

COMMERCIAL STATISTICS.

The following statistics have been furnished by the Georgia and Alabama Steamboat Company and the Lathrop-Hatten Lumber Company.

Stern-wheel steamboats.	Registered tonnage.	Draft.		Between—	Passengers.
		Light.	Loaded.		
		Inches.	*Inches.*		
Willie C. Wagnon	151	18	52	Rome, Ga., and Gadsden, Ala., and Locks 1, 2, 3, and 4, Alabama.	3,150
Connasaugua	81	17	48	Carters, Ga., and Gadsden, Ala.	
Sporter	54	12	36	Carters, Ga., and Rome, Ga.	

Freight carried.

Articles.		Quantity.	Tons.
Cotton	bales	10,000	2,500
Cotton seed	sacks	30,000	1,500
Cotton-seed meal	do	5,000	250
Fertilizers	do	20,000	2,000
Oats	do	6,000	500
Corn	do	15,000	1,200
Hay	bales	12,000	600
Flour	barrels	3,500	350
Sugar	do	600	110
Molasses	do	400	120
Bagging	rolls	2,500	125
Ties	bundles	3,000	65
General miscellaneous	packages	20,000	1,500
Hides and skins	do	100	5
Live stock	head	150	100
Lumber	feet	9,000,000	22,500
Staves	pieces	500,000	500
Provisions (case goods)	packages	2,500	1,000
Coffee	sacks	600	85
Corn meal	do	12,000	180
Bacon, smoked and dry salted	boxes	2,500	125
Salt	sacks	3,000	225
Lard	packages	1,500	40
Soap	boxes	1,200	50
Nails	kegs	1,200	60
Shingles	number	1,500,000	375
Brick	do	250,000	625
Total			36,640

Estimated value of above freights, $1,800,000.

In addition to freight carried by steamboats, the Lathrop-Hatten Lumber Company estimate that they rafted down the river during past fiscal year 3,000,000 feet of saw logs, valued at $15,000.

2. BETWEEN WETUMKA AND EAST TENNESSEE, VIRGINIA AND GEORGIA RAILROAD BRIDGE.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1902.

The property belonging to the improvement was properly cared for. Such repairs were made to the lock-house, carpenter shop, blacksmith shop, and general storage shed as were found necessary.

The steam towboat *Coosada*, purchased in 1891, was an old boat when bought, and now can hardly be kept afloat. This boat requires an entire new hull. She has been condemned and advertised to be sold, but no offer had been received at the close of the fiscal year.

The money available being insufficient for other operations, it is recommended that no further work be done upon this division of the river except such as may be necessary to care for buildings and property now on hand at Wetumka, Ala.

Money statement.

July 1, 1901, balance unexpended		$27,479.35
Amount appropriated by river and harbor act approved June 13, 1902		35,000.00
		62,479.35
June 30, 1902, amount expended during fiscal year		1,803.71
July 1, 1902, balance unexpended		60,675.64
July 1, 1902, outstanding liabilities		1,249.05
July 1, 1902, balance available		59,426.59
Amount (estimated) required for completion of existing project		6,059,913.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$387,000.00	
For maintenance of improvement	30,000.00	
		417,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

September 19, 1890	$150,000
July 13, 1892	100,000
August 18, 1894	110,000
June 3, 1896	50,000
	410,000
Less amount transferred by act of June 13, 1902, to upper division of river	10,000
Total	400,000

R 13.

OPERATING AND CARE OF CANALS AND OTHER WORKS OF NAVIGATION ON COOSA RIVER, GEORGIA AND ALABAMA.

Locks Nos. 1, 2, and 3 were opened to navigation June 30, 1890, and have been operated continuously, except during February, 1895, when the canal between Locks Nos. 2 and 3 was frozen over for a period of ten days. During the fiscal year ending June 30, 1899, Lock No. 3 was closed to navigation from January until June while the lock was undergoing repairs. In February, 1899, while the lock was being repaired, the temperature fell to −8½°, the lowest recorded temperature for this locality.

The amount expended to the end of the fiscal year ending June 30, 1901, was $64,538.49.

During the year ending June 30, 1902, the locks were operated continuously.

An allotment was made July 31, 1901, which included the following work:

For repairs to and raising crest of Dam No. 4	$32,000
For strengthening cofferdam at Lock No. 4	5,370
For building new hull for dredge	7,000
	44,370

Work was confined to repairing the permanent dam and cofferdam at Lock No. 4 and to renewing hull of the dredge. These repairs being more urgent, the entire working plant was required to prosecute them and was not therefore available for making the minor repairs required at Locks Nos. 1, 2, and 3.

At the end of the fiscal year the repairs to Dam No. 4 were two-thirds completed, the dredge hull was finished, the machinery had been transferred, and dredge was at work again.

The drawings herewith show two sections of Dam No. 4, as repaired, No. 1 being a section at an uninjured part of the original dam, and No. 2 a section at the break referred to in the Report of the Chief of Engineers U. S. Army for 1901, Part III, page 1789.

In repairing this dam a sheet-pile bulkhead or breakwater was constructed of piles 4 by 12 inches by 20 feet, driven along the face of the original dam, with their joints broken by additional sheet piles 2 by 12 inches by 20 feet, the tops of these piles extending 5 feet above crest of dam, as shown at "a" on the sections. This height placed the tops of the piles 2 feet above the repaired dam. The bulkhead was extended halfway across the river, the other half of the dam acting as a spillway. In places the bottom, at the toe of the original dam, had scoured out to a depth of 12 to 15 feet; the dam itself had moved 2 feet downstream and the crest lowered 1 foot. The holes scoured in the foundation were filled with stones containing 2 to 3 cubic yards each, and the filling was carried 12 to 15 feet beyond the toe of dam and brought approximately to elevation of low water. The fill serves not only as a foundation for the new slope but acts as an apron to prevent further scour. The wooden coping on crest and steps of the original dam was taken out (where there was any left) a little in advance of the new masonry. In many places the steps were gone entirely, leaving only the part under the crest shown at "c," "d," "e," and "f". Stiff-leg derricks, erected 4 to 8 feet below toe of dam, were employed in placing the slope and heavy stones of the filling. On portions of the dam that were not within reach of the derricks the slope was set with the dredge, which was also employed in unloading from barges the stone used. The derricks were operated by hoisting engines placed on the banks. As each derrick finished the portion of dam within its reach it was moved farther out. This operation was continued from the west bank until five derricks had been erected and one-half of the repairs finished, when the derricks, hoisting engines, and boiler were moved to the east bank and set up and the repairs commenced from that side. The closure will be made at the center of the dam. On the completion of the west half of the dam the sheet-pile bulkhead was cut off along the line "f". During the progress of the work the filling, "m," "n," and "o," in front of the dam was carried on and finished simultaneously with the slope below. A sheet-pile bulkhead or breakwater, similar to that from the west bank, was driven from the east bank to the finished work; the piles in this bulkhead were driven with their tops 7 feet above crest of original dam. This height gives 4 feet above the finished dam which now acts as a spillway. The methods of construction are the same as those employed in constructing the west half. The stone used in this work was obtained from quarries at Collins Spring, a distance of 7 miles up the river. The stone is a heavy, fine-grained limestone weighing 171 pounds to the cubic foot. Those built into the slope contain 1 to 3 cubic yards each.

The machinery was transferred from the old dredge to the new hull while the derricks, engines, etc., were being moved from the west to the east bank, and in this way no time was lost.

Temporary repairs were made to cofferdam at head of the site proposed for Lock No. 4 before work of repairs was begun on the permanent dam.

Early in April, 1902, the cofferdam was partly destroyed. The water broke through the portion situated above the head of the proposed lock, and which acts, during the construction of the lock, as a part of the main dam. The structure for about one-half its depth was carried away. Repairs were completed before any further damage occurred, and the structure is now as safe as it can be made.

As stated in the beginning of this report, the repairs at Lock No. 4 being the more urgent no other work provided for in the allotment was done, except some dredging at Locks Nos. 1, 2, and 3 at beginning of fiscal year, the plant available not being sufficient to carry on all work at once.

Summary of expenditures made during the fiscal year ending June 30, 1902, at Locks 1, 2, and 3, and Dam No. 4, Coosa River, Georgia and Alabama, under the indefinite appropriation for operating and care of canals, etc.

Services	$30,633.50
Supplies, etc	2,764.62
Material	3,527.84
Provisions and ice	3,902.75
Fuel	1,211.02
Rent	66.67
Total	42,106.40

Money statement.

July 1, 1901, balance unexpended	$2,004.35
Amount allotted by Secretary of War	48,200.22
July 1, 1901, balance unexpended	50,204.57
June 30, 1902, amount expended during fiscal year	42,106.40
July 1, 1902, balance unexpended	8,098.17
July 1, 1902, outstanding liabilities	3,821.23
July 1, 1902, balance available	4,276,94

R 14.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

The stern-wheel river steamboat *Mascot*, 128 feet long, sunk in the Flint River, 6 miles below Bainbridge, Ga., in 1899, began to obstruct navigation in the low-water season of 1900. An allotment of $250 was asked for and received from the permanent indefinite appropriation carried by the river and harbor act approved March 3, 1899.

This wreck was removed during the fiscal year.

APPENDIX S.

IMPROVEMENT OF RIVERS AND HARBORS IN WESTERN ALABAMA AND EASTERN MISSISSIPPI, AND OF BOGUE CHITTO, LOUISIANA.

REPORT OF CAPT. SPENCER COSBY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Harbor at Mobile, Alabama.
2. Black Warrior River, Alabama, from Tuscaloosa to Daniels Creek.
3. Warrior and Tombigee rivers, Alabama and Mississippi.
4. Operating and care of locks and dams on Black Warrior River, Alabama.
5. Noxubee River, Mississippi.
6. Pascagoula River and Horn Island Harbor, Mississippi.
7. Pascagoula River, Mississippi.
8. Chickasahay River, Mississippi.
9. Leaf River, Mississippi.
10. Harbor at Biloxi, Mississippi.
11. Channel from Gulfport to Ship Island Harbor, Mississippi.
12. Pearl River below Rockport, Mississippi.
13. Pearl River between Carthage and Jackson, Mississippi.
14. Pearl River between Edinburg and Carthage, Mississippi.
15. Bogue Chitto, Louisiana.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., July 16, 1902.

GENERAL: I have the honor to forward herewith my annual reports for the fiscal year ending June 30, 1902, on the various works of rivers and harbors in the Mobile district.

Very respectfully, your obedient servant,

SPENCER COSBY,
Captain, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

S 1.

IMPROVEMENT OF HARBOR AT MOBILE, ALABAMA.

An account of this improvement is contained in the Annual Reports of the Chief of Engineers for 1896, page 1425, and 1900, page 2161.

During the past fiscal year no work of dredging has been accomplished in connection with the improvement of Mobile Harbor, available funds having been insufficient for such work.

In November, 1901, in order to clear the dredged channel of snags, sunken logs, and similar obstructions, which endangered navigation, a project was submitted for the expenditure of a portion of the small balance remaining available for this improvement in the work of freeing the channel from such obstructions. This project was approved under date of November 22, 1901, and work under it commenced in December, 1901, and continued until February 14, 1902, operations being carried on by the U. S. snag boat *Demopolis* and hired labor. Subsequent to the latter date the joint rivers and harbors committee of Mobile was permitted, by authority of the Secretary of War, to continue the snag boat *Demopolis* in commission on the work of removing obstructions from the channel at its own expense, without the plant passing out of the possession of an agent of the United States. This use of the snag boat was continued until March 31, 1902, when the channel was reported as being free from such obstructions.

The river and harbor act approved June 13, 1902, made the following provision for continuing the improvement of Mobile Harbor:

> Improving harbor at Mobile, Alabama: Continuing improvement, three hundred thousand dollars: *Provided,* That a contract or contracts may be entered into by the Secretary of War for such materials and work as may be necessary, with the view of ultimately securing a channel twenty-three feet deep and one hundred feet wide at the bottom, with appropriate side slopes, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate two hundred thousand dollars, exclusive of the amount herein and heretofore appropriated, of which amount herein appropriated ten thousand dollars, or so much thereof as may be necessary, may, in the discretion of the Secretary of War, be used in the removal of deadheads, sunken logs, and other obstructions arising from the winter and spring freshets on the rivers entering into Mobile Bay: *Provided further,* That of this appropriation the Secretary of War may, in his discretion, expend a sum not to exceed fifty thousand dollars in deepening and widening the channel through the outer bar near Fort Morgan.

The provision contained in this act for commencing the work of widening and deepening the channel through the outer bar near Fort Morgan modifies the existing project for the improvement of Mobile Harbor so as to include the execution of the outer-bar work. A project for the expenditure of the appropriations made in this act will be submitted early in the coming fiscal year.

In the latter part of April, 1902, a detailed survey, including triangulation, to determine the present condition of the ship channel within the limits of the project was commenced. This survey is still in progress.

Money statement.

July 1, 1901, balance unexpended		$4,111.34
Amount appropriated by river and harbor act approved June 13, 1902		300,000.00
		304,111.34
June 30, 1902, amount expended during fiscal year		3,756.73
July 1, 1902, balance unexpended		300,354.61
July 1, 1902, outstanding liabilities		215.00
July 1, 1902, balance available		300,139.61
Amount (estimated) required for completion of existing project		740,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$540,000.00	
For maintenance of improvement	60,000.00	
		600,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

By act of—		
May 20, 1826	$10,000.00	
March 2, 1829	20,000.00	
June 24, 1834	10,000.00	
March 3, 1835	17,997.60	
March 3, 1837	50,000.00	
July 7, 1838	50,000.00	
August 3, 1852	50,000.00	
		$207,997.60
March 3, 1857 (relief claim)		20,833.08
July 11, 1870	50,000.00	
March 3, 1871	50,000.00	
June 10, 1872	75,000.00	
March 3, 1873	100,000.00	
June 23, 1874	100,000.00	
March 3, 1875	26,000.00	
		401,000.00
June 18, 1878 (survey)	10,000.00	
March 3, 1879	100,000.00	
June 14, 1880	125,000.00	
March 3, 1881	100,000.00	
August 2, 1882	125,000.00	
July 5, 1884	200,000.00	
August 6, 1886	90,000.00	
		750,000.00
August 11, 1888	250,000.00	
September 19, 1890	350,000.00	
July 13, 1892	212,500.00	
March 3, 1893	500,000.00	
August 18, 1894	390,000.00	
March 2, 1895	291,300.00	
March 16, 1896	160,000.00	
June 3, 1896 (maintenance)	60,000.00	
June 4, 1897 (maintenance)	25,000.00	
July 1, 1898 (maintenance)	30,000.00	
		2,268,800.00
March 3, 1899	100,000.00	
June 6, 1900	500,000.00	
June 13, 1902	300,000.00	
		900,000.00
Total		4,548,630.68

COMMERCIAL STATISTICS.

[Statistics furnished by the United States custom-house, Mobile, Ala., showing the business of the port of Mobile for the calendar year ending December 31, 1901.]

Exports	$11,893,116
Imports	[a]2,989,018
Total	14,882,134

Vessels.	Entered, 1901.		Cleared, 1901.	
	Number.	Tons.[b]	Number.	Tons.[b]
Foreign	749	532,676	729	514,211
Coastwise	61	58,104	84	78,810
Total	810	590,780	813	593,021

[a] Valuation at point of shipment.

[b] Registered net tonnage.

Foreign commerce.

The following statement concerning the foreign commerce of the port of Mobile for the calendar year ending December 31, 1901, has been compiled from the records of the United States custom-house and from the reports of shippers, consignees, and carriers:

Articles.	1901.	
	Tons.	Value.
IMPORTS.		
Bananas	56,371	$2,118,900
Cocoanuts	2,910	87,300
Sisal grass	12,729	1,272,900
Mahogany	3,615	76,070
Sulphur ore	20,053	57,329
Manganese ore	3,100	44,000
Miscellaneous	4,500	125,000
Total	103,278	3,776,499
EXPORTS.		
Corn	30,024	626,154
Coal	260,415	858,050
Lumber	136,802	1,520,020
Timber	195,737	2,392,346
Oats	2,756	79,713
Cotton	14,688	2,660,551
Cattle	6,520	462,070
Hog products	8,098	1,474,598
Flour	26,100	1,021,527
Cars and parts of cars	756	42,001
Manufactured goods and miscellaneous	9,900	756,091
Total	691,796	11,893,116

The following lines of steamships operate between Mobile, Ala., and foreign ports:

United Fruit Company, Central American ports.

Orr & Laubenheimer Steamship Company, Central American ports.

Camors-McConnell Steamship Company, Central American ports.

John B. Cefalu & Co., Central American ports.

Munson Line, Cuban ports.

Atlantic and Mexican Gulf Steamship Company, Mexican ports.

International Steamship Company, all ports.

Mobile Transatlantic Line, English and German ports.

No changes have occurred in the past year in the number of steamship lines operating from the port of Mobile.

Coastwise and domestic commerce.

The following statement concerning the coastwise and domestic commerce of the port of Mobile for the calendar year ending December 31, 1901, has been compiled from the records of shippers, consignees, and carriers:

Articles.	1901.	
	Tons.	Value.
ARRIVING.		
Naval stores	36,944	$923,600
Coal (anthracite)	4,767	38,136
Cotton	36,076	6,654,440
Cord wood and hard wood	100,000	300,000
Oysters, fish, etc	5,600	272,000
Logs	400,000	2,000,000
Staves	22,985	689,550
Miscellaneous	35,000	315,000
Total	641,372	11,192,726
DEPARTING.		
Manufactured goods and miscellaneous	180,000	1,620,000

Comparative statement of the number and draft of vessels passing up and down the dredged channel for the calendar years ending December 31, 1900 and 1901.

[Compiled from the books of the harbor master at Mobile, Ala.]

Draft.	Steamships.				Square-rigged vessels.			
	Up.		Down.		Up.		Down.	
	1900.	1901.	1900.	1901.	1900.	1901.	1900.	1901.
Less than 13 feet	331	352	165	189	71	63	....	2
13 to 14 feet	114	156	84	71	33	30	....	2
14 to 15 feet	66	44	105	89	29	25	13	6
15 to 16 feet	23	8	44	57	13	15	11	13
16 to 17 feet	12	2	25	36	2	4	8	8
17 to 18 feet	14	....	37	27	2	....	4	9
18 to 19 feet	8	6	29	21	2	1	18	19
19 to 20 feet	9	2	26	28	3	....	18	8
20 to 21 feet	5	1	34	31	....	....	24	18
21 to 22 feet	1	1	21	11	....	....	36	31
22 to 23 feet	....	....	13	12	....	....	23	22
Total	583	572	583	572	155	138	155	138

	Schooners and sea-going barges.				Total.			
	Up.		Down.		Up.		Down.	
	1900.	1901.	1900.	1901.	1900.	1901.	1900.	1901.
Less than 13 feet	184	155	100	97	586	570	265	288
13 to 14 feet	1	2	25	19	148	188	109	92
14 to 15 feet	....	1	29	11	95	70	147	96
15 to 16 feet	1	4	9	2	37	27	64	72
16 to 17 feet	1	1	6	5	15	7	39	49
17 to 18 feet	....	....	4	25	16	....	45	61
18 to 19 feet	1	2	6	4	11	9	53	44
19 to 20 feet	2	1	2	11	14	3	46	47
20 to 21 feet	....	1	6	2	5	2	64	51
21 to 22 feet	....	....	3	1	1	1	60	43
22 to 23 feet	....	....	....	....	....	....	36	34
Total	190	167	190	167	928	877	928	877

Tonnage of vessels entered and cleared at the five leading Gulf ports, years ended June 30, 1890, 1895, and 1900.

[From the report of the Isthmian Canal Commission.]

Port.	1890.	1895.	Gain in 5 years.	1900.	Gain in 10 years.	Gain in 10 years.
						Per cent.
Port Tampa	9,080	174,466	165,376	208,595	199,515	2,197.30
Pensacola	815,778	703,380	(a)	1,115,382	299,604	36.73
Mobile	254,012	532,399	278,386	1,054,471	800,459	315.13
New Orleans	2,035,072	1,997,769	(a)	3,395,442	1,360,370	66.85
Galveston	343,575	767,629	424,054	1,538,300	1,194,725	347.73
Total	3,457,517	4,175,643	718,126	7,312,190	3,854,673	111.49

[a] Decrease.

S 2.

IMPROVEMENT OF BLACK WARRIOR RIVER FROM TUSCALOOSA TO DANIELS CREEK.

An account of this work is printed in the Annual Report of the Chief of Engineers for 1897, page 1667. The improvement is based on the report of a Board of Engineers published in the Annual Report of the Chief of Engineers for 1887, page 1302.

WORK OF THE PAST YEAR.

Operations consisted principally in contract work on Lock 4. Fair progress was made for the force employed, but the latter was inadequate for economical prosecution of the work, only one gang of masons and small forces of quarrymen and stonecutters being employed most of the time. The building of the bank wall of lock was continued until January, when it was discontinued owing to prevailing high water. The building of the river wall of lock was then resumed with a floating derrick and continued, with occasional flood interruptions, until May. It was discontinued in May in order that construction of the abutment and abutment end of dam might be resumed. This work has since been prosecuted under very favorable conditions of weather and river. During May work was begun on a 150-foot section of cofferdam for the lock end of the dam. It is completed above low water and has been pumped out; excavation for the dam foundations is in progress.

WORK ACCOMPLISHED.

The following work has been done by the contractors on Lock 4:

July 1, 1901, to June 30, 1902, inclusive.

Quoins	cubic yards	34
Coping	do	22
Pointed-face masonry	do	869
Rock-face masonry	do	491
Rubble masonry	do	3,447
Dry rubble masonry	do	728
Excavation	do	3,524
Rock excavation	do	755
Embankment	do	145
Stone filling	do	168
Bolt holes	linear feet	6
Framed timber	feet B. M.	2,040
Sheathing	do	24,560
Sheathing used again	do	2,148

Total to and including June 30, 1902.

Quoins	cubic yards	88
Coping	do	22
Pointed-face masonry	do	1,996
Rock-face masonry	do	1,158
Rubble masonry	do	5,839
Dry rubble masonry	do	1,152
Excavation	do	7,405
Rock excavation	do	1,107
Embankment	do	145
Stone filling	do	338
Bolt holes	linear feet	38
Framed timber	feet B. M.	13,319
Sheathing	do	25,964
Sheathing used again	do	2,148
Grubbing and clearing	per cent	60

GATES AND IRONS.

Gates, valves, and special irons for Lock 4 have been built at the Tuscaloosa shops, where the gates and valves are still stored. Most of the special irons have been delivered at the lock site, and are being built into place by the contractors as the work proceeds. It is not probable that the gates will be erected before the summer of 1903.

NAVIGATION AND COMMERCE.

The bulk of the traffic on this part of the river passes through Locks 1, 2, and 3, and is given in detail in the report on "Operating and care of locks and dams on Black Warrior River, Alabama." In addition to this there is a small traffic in coal and timber on the pool above Lock 3, statistics of which are not available. A large development of traffic is hardly to be expected until the river is opened below.

The river and harbor act approved June 13, 1902, provides for the transfer of $14,000 of the unexpended balance of appropriations made for the Warrior River to the work of completing Lock 4, Black Warrior River. The same act also provides for a survey for the location of sites for Locks 5 and 6 on this stream and extends the upper limit of the improvement to the junction of the Mulberry and Locust Forks of the Black Warrior River, 46½ miles above Tuscaloosa.

Money statement.

July 1, 1901, balance unexpended	$131,640.08
Amount transferred by river and harbor act approved June 13, 1902, from appropriation for Locks 4, 5, and 6, Warrior River, Ala	14,000.00
	145,640.08
June 30, 1902, amount expended during fiscal year	52,249.24
July 1, 1902, balance unexpended	93,390.84
July 1, 1902, outstanding liabilities	15,500.00
July 1, 1902, balance available	77,890.84
July 1, 1902, amount covered by uncompleted contracts	58,382.17
Amount (estimated) required for completion of existing project	Indefinite.
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	200,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

By act of—	
July 5, 1884	$50,000
August 1, 1886	56,250
August 11, 1888	100,000
September 19, 1890	150,000
July 13, 1892	200,000
August 18, 1894	37,500
June 3, 1896	10,000
March 3, 1899	50,000
June 6, 1900	86,824
By act of—	
March 3, 1901	53,676
Amount transferred from unexpended balance of appropriations for Warrior River by act of—	
June 13, 1902	14,000
Total	808,250

CONTRACT IN FORCE.

With Willard & Cornwell, dated September 28, 1899, approved by the Chief of Engineers November 2, 1899, for the construction of Lock and Dam No. 4, Black Warrior River, Alabama, for $163,348. Work commenced November 20, 1899; continuing contract; to be completed by December 31, 1902, the time of completion having been extended one year.

LOCK AND DAM NO. 4, BLACK WARRIOR RIVER, ALABAMA.

[Printed in House Doc. No. 239, Fifty-seventh Congress, first session.]

Office of the Chief of Engineers,
United States Army,
Washington, December 20, 1901.

Sir: The river and harbor act of March 3, 1899, authorized the improvement of Black Warrior River, Alabama, by the construction of Lock and Dam No. 4, at a cost not to exceed $190,500. The work of construction, which has been proceeding under contract, shows that the amount of rock excavation and the volume of masonry necessary for the completion of the lock and dam will be greater than was anticipated when the estimate was first made. The district engineer officer estimates that the additional sum of $14,000 will be needed to complete the structure.

In the said act Congress also provided for the improvement of Warrior and Tombigbee rivers by the construction of three locks and dams, numbered 4, 5, and 6. Careful study of the cost of completing these locks and dams, work on which is now in progress under contract, shows that they can be completed for a sum $14,000 less than was originally estimated and provided for by Congress.

The transfer of $14,000 from the appropriation for improving Warrior and Tombigbee rivers to the work of improving Black Warrior River is desirable in the public interest, and I have the honor to recommend that the papers be transmitted to the Speaker of the House of Representatives for the information of the Committee on Rivers and Harbors.

Very respectfully, your obedient servant,

G. L. Gillespie,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. Elihu Root,
Secretary of War.

REPORT OF CAPT. SPENCER COSBY, CORPS OF ENGINEERS.

United States Engineer Office,
Mobile, Ala., November 25, 1901.

General: I have the honor to submit the following estimate of the total cost of completing the construction of Lock and Dam No. 4, Black Warrior River, Alabama, work on which is now proceeding under contract with Willard & Cornwell, dated September 28, 1899:

Lock and dam, contract with Willard & Cornwell (estimated)	$166,260
Lock tender's house, contract with George T. Eckert	1,400
Engineering to October 1, 1901	7,600
Gates, valves, and irons to October 1, 1901	8,400
Mobile office expenses to October 1, 1901	3,000
Engineering, October 1, 1901, to December 31, 1902, $6,000, less $1,500 paid by contractors, September 1, 1902, to December 31, 1902 (estimated)	4,500
Completion of gates, valves, and irons (estimated)	4,000
Mobile office expenses, October 1, 1901, to December 31, 1902 (estimated)	1,800
Additional buildings (estimated)	3,000
Incidentals (estimated)	4,540
Total	204,500

The total appropriation for this work is $190,500, leaving an estimated deficiency of $14,000. One reason for the existence of this deficiency is that the depth of rock excavation under the lock walls has proved greater than was anticipated, and this has increased both the amount of rock excavation and the volume of masonry.

Careful estimates have just been made of the cost of completing Locks and Dams Nos. 4, 5, and 6, Warrior River, work on which is now in progress under contract with Messrs. Christie, Lowe & Heyworth. These estimates show that the amount appropriated for Locks 4, 5, and 6 will be more than sufficient to complete them, and that $14,000 can be safely spared from the appropriation.

I therefore have the honor to recommend that Congress be asked to authorize the transfer of not exceeding $14,000, appropriated for "Improving Warrior and Tombigbee rivers, Alabama," to the work of "Improving Black Warrior River, Alabama, from Tuscaloosa to Daniels Creek."

Very respectfully, your obedient servant,

SPENCER COSBY,
Captain, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.
(Through the Division Engineer).

[First indorsement.]

OFFICE DIVISION ENGINEER, GULF DIVISION,
New Orleans, La., November 27, 1901.

Respectfully forwarded to the Chief of Engineers, United States Army, concurring in the recommendation of Captain Cosby.

H. M. ADAMS,
Lieut. Col., Corps of Engineers,
Division Engineer.

S 3.

IMPROVEMENT OF WARRIOR AND TOMBIGBEE RIVERS, ALABAMA AND MISSISSIPPI.

This system of rivers forms the highway for the coal coming down the Black Warrior River, as well as the natural communication for that part of western Alabama and eastern Mississippi that lies contiguous to the Upper Tombigbee.

The work done on this system has heretofore been divided into sections, as follows:

(*a*) Warrior River, from the mouth to Tuscaloosa, a distance of 130½ miles.

(*b*) Tombigbee River, from mouth to Demopolis, a distance of 185 miles.

(*c*) Tombigbee River, from Demopolis, Ala., to Columbus, Miss., a distance of 156 miles.

(*d*) Tombigbee River, from Columbus to Fulton, a distance of 144 miles.

(*e*) Tombigbee River, from Fulton to Walkers Bridge, a distance of 40 miles.

The approved projects on sections *a*, *b*, and *c* propose the use of locks and dams; on *d* and *e* only snagging and temporary work in the way of dikes, etc., are proposed.

To maintain navigation on these rivers it will be necessary to keep up the removal of the snags and obstructions which accumulate annually, and also to dredge some sand and gravel from localities in the river which have shoaled since the suspension of operations for improvement.

(*a*) WARRIOR RIVER, ALABAMA.

PLAN OF IMPROVEMENT.

To afford a channel for barges of 6 feet draft from Tuscaloosa, Ala., to the junction with the Tombigbee River near Demopolis, Ala., a distance of 130½ miles, by construction of locks and dams, dredging in pools, revetting banks, and removal of snags, overhanging trees, and similar obstructions to navigation.

WORK OF THE PAST YEAR.

Operations were largely confined to contract work on Locks 4, 5, and 6. A large rise in August and smaller ones in September and October, together with malarial sickness, greatly retarded the work. In spite of these difficulties construction was prosecuted vigorously until the middle of December, when winter floods set in and caused suspension of active construction. At this time pile foundations were completed for the three locks and were partly driven for the dams and abutments. About 26 per cent of the concrete for lock walls was placed at Lock 4, about 69 per cent at Lock 5, and about 88 per cent at Lock 6.

During the winter the contractors re-opened their quarry near Tuscaloosa, leased a towboat, and delivered by water 3,598 cubic yards of stone at Lock 5 and 2,752 cubic yards at Lock 6. This stone is to be used for filling the dams and riprapping the banks. Coal and other supplies were delivered in the same manner until about May 1.

Early in May active construction was resumed on the three locks, and has been rapidly prosecuted since under very favorable conditions as to weather and river stages.

WORK ACCOMPLISHED.

The following work has been done by the contractors:

July 1, 1901, to June 30, 1902, inclusive.

	Lock 4.	Lock 5.	Lock 6.
Concrete .... cubic yards..	4,597	10,008	10,893
Excavation .... do....	58,330	13,184	19,517
Gravel filling .... do....	....	335	698
Miter sills .... feet B. M..	2,408	3,690	3,690
Floor timber .... do....	23,030	42,727	115,879
Sheathing .... do....	166	....	....
Sheet piling .... do....	145,978	181,966	187,433
Foundation piles .... linear feet..	30,440	34,979	33,655
Foundation piles cut off .... do....	11,853	12,603	17,027
Drain pipe .... do....	56	376	379
Grubbing and clearing .... per cent..	20	....	5

Total to and including June 30, 1902.

	Lock 4.	Lock 5.	Lock 6.
Concrete ....cubic yards..	4,597	10,008	10,893
Excavation ....do....	101,197	47,079	59,777
Gravel filling ....do....		835	698
Miter sills ....feet B. M..	2,408	3,690	3,690
Floor timber ....do....	23,030	42,727	115,679
Sheathing ....do....	166		
Sheet piling ....do....	190,330	273,880	293,151
Foundation piles ....linear feet..	30,440	36,909	38,807
Foundation piles cut off ....do....	11,853	12,923	17,147
Drain pipe ....do....	56	376	379
Grubbing and clearing ....per cent..	90	80	95

PRESENT CONDITION OF WORK.

At Lock 4 about 46 per cent of concrete for lock walls is placed, about 41 per cent of pile foundations for abutment are driven, and practically no work has been done on the dam. About 21 per cent of lock-floor timber is placed. Total contract work is about 55 per cent completed.

At Lock 5 the lock walls are about 98 per cent finished, lock floor is about 38 per cent placed, abutment pile foundations are finished, and pile foundations for dam are about 71 per cent completed. Total contract is about 71 per cent completed.

At Lock 6 the lock walls and floor are finished, abutment concrete is about 73 per cent placed, and pile foundations for dam are about 74 per cent completed. Total contract work is about 83½ per cent completed.

GATES AND IRONS.

Gates, valves, and special irons for Locks 4, 5, and 6 have been built at the Tuscaloosa shops and delivered at the lock sites, the U. S. steamer *Tombigbee* delivering the gates during April, 1902. The valves and irons are being built into place by the contractors as the work proceeds. It is proposed to erect the gates by hired labor during the remainder of 1902, beginning in July and finishing consecutively at Locks 6, 5, and 4, the work being done as far as practicable at each lock before the construction of the dams raises the water sufficiently to interfere.

LOCKS 1, 2, AND 3.

Surveys and borings for these locks were completed and the sites located during 1900. Work on the detailed plans and specifications is well advanced, and it is proposed to arrange as soon as practicable for their construction under contract. These three locks, with Locks 4, 5, and 6, now building, will complete the Warrior system.

NAVIGATION AND COMMERCE.

The principal traffic on the upper part of the stream during the year consisted of materials for construction of Locks 4, 5, and 6, and the bulk of this is included in the traffic of 5,090 tons through Lock 1, Black Warrior River, given in detail in the report on "Operating and care of locks and dams on Black Warrior River, Alabama." In addition to this, steamboats from Mobile made occasional trips, carrying cotton and plantation supplies, and there was considerable rafting of logs to mills in Demopolis, no statistics of which are available. A large development of traffic is hardly to be expected until the lock system is completed.

The river and harbor act approved June 13, 1902, contains the following:

> Improving the Black Warrior, the Warrior, and the Tombigbee rivers, Alabama: Continuing improvement with a view to securing a navigable depth of 6 feet in said rivers from Mobile to Mulberry and Locust forks in said Black Warrior River, $374,000: *Provided*, That a contract or contracts may be entered into by the Secretary of War for such materials and work as may be necessary for constructing locks and dams 1, 2, and 3, in the Tombigbee and Warrior rivers, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate $500,000, exclusive of the amounts herein and heretofore appropriated: *Provided further*, That $10,000 of the amounts herein or heretofore appropriated for said project may, in the discretion of the Secretary of War, be expended for continuing improvement and for maintenance on said river from Tuscaloosa to Demopolis; and the Secretary of War is authorized and directed to cause a survey to be made to determine the location of the necessary lock sites in Tombigbee River between Demopolis and McGrews shoals, and of locks 5 and 6 in the Black Warrior. An unexpended balance of $14,000 remaining from the appropriation heretofore made for the construction of locks and dams numbered 4, 5, and 6, on the Warrior River, is hereby transferred to be expended for the improvement of Black Warrior River in the completion of lock numbered 4.

A project for the expenditure of the funds above appropriated will be submitted early in the coming fiscal year.[a]

Money statement.

July, 1901, balance unexpended		$477,009.55
Amount transferred to Black Warrior River, Alabama, by river and harbor act approved June 13, 1902		14,000.00
		463,009.55
Amount appropriated by river and harbor act approved June 13, 1902		374,000.00
		837,009.55
June 30, 1902, amount expended during fiscal year		189,916.88
July 1, 1902, balance unexpended		647,092.67
July 1, 1902, outstanding liabilities		67,000.00
July 1, 1902, balance available		580,092.67
July 1, 1902, amount covered by uncompleted contracts		154,029.00
Amount (estimated) required for completion of existing project		500,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$500,000.00	
For maintenance of improvement	20,000.00	
		520,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

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[a] A map of a portion of Alabama showing the projected system of improvement of Mobile, Tombigbee, Warrior, and Black Warrior rivers accompanies this report.

APPROPRIATIONS.

For Warrior and Tombigbee rivers:		
By act of—		
March 3, 1875		$25,000.00
August 14, 1876		15,000.00
June 18, 1878		28,000.00
March 3, 1879		20,000.00
For Warrior River:		
By act of—		
June 14, 1880		20,000.00
March 3, 1881		10,622.00
August 2, 1882		10,000.00
July 5, 1884		12,000.00
August 5, 1886		18,750.00
August 11, 1888		18,000.00
September 19, 1890		45,000.00
July 13, 1892		75,000.00
August 18, 1894		40,000.00
June 3, 1896		70,000.00
March 3, 1899		220,000.00
June 6, 1900		200,000.00
March 3, 1901		240,000.00
Allotted from emergency act of June 6, 1900	$4,000.00	
Less unexpended balance of above allotment turned back into the Treasury	308.76	
		3,691.24
By act of June 13, 1902		374,000.00
Total		1,445,063.24
Less amount transferred to improvement Black Warrior River by act of June 13, 1902		14,000.00
		1,431,063.24

CONTRACTS IN FORCE.

With Christie, Lowe & Heyworth, dated February 19, 1900, approved by the Chief of Engineers March 10, 1900, for the construction of Locks and Dams Nos. 4, 5, and 6, Warrior River, Alabama, for $149,454.40, $132,135.40, and $135,640.40, respectively. Work commenced April 5, 1900; continuing contract; to be completed December 31, 1903, time of completion having been extended two years.

Supplemental contract with Christie, Lowe & Heyworth, dated April 29, 1902, approved by the Chief of Engineers May 22, 1902, for increase in materials to be furnished in the construction of Locks and Dams Nos. 4, 5, and 6, Warrior River, Alabama, and for the increase in price of excavation at Lock No. 5.

LOCKS AND DAMS NOS. 1, 2, AND 3, WARRIOR AND TOMBIGBEE RIVERS.

[Printed in House Doc. No. 165, Fifty-seventh Congress, first session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, December 20, 1901.

SIR: The emergency river and harbor act of June 6, 1900, provided for a survey of Warrior and Tombigbee rivers, in the State of Alabama, with a view to the construction of locks and dams numbered one, two, and three, between the mouth of said rivers and Tuscaloosa.

The report on this survey was made by Maj. W. T. Rossell, Corps of Engineers, under date of December 4, 1900, and was printed as House Doc. No. 178, Fifty-sixth Congress, second session. In this report it was estimated that the three locks and dams could be constructed for $760,000. This estimate, however, was made before the detailed surveys were entirely completed, in order that the matter have the consideration of Congress at the last session.

The completion of the surveys and borings and the experience gained during the past year in lock and dam construction in the vicinity show that a larger amount of work than was originally contemplated must be provided for, and the officer at present in charge of the district, after careful study, estimates that the three locks and dams will cost $874,000. A copy of his report, giving the details of his estimate, is herewith, and I beg to recommend that it be transmitted to the Speaker of the House of Representatives for the information of the Committee on Rivers and Harbors.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. ELIHU ROOT,
Secretary of War.

REPORT OF CAPT. SPENCER COSBY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., December 13, 1901.

GENERAL: I have the honor to submit herewith revised estimates, amounting to $874,000, of the cost of constructing Locks and Dams Nos. 1, 2, and 3, Warrior River, Alabama.

1. The present approved estimate of $760,000 for this work, submitted by Major Rossell, in report dated December 4, 1900, and printed in House Doc. No. 178, Fifty-sixth Congress, second session, was prepared before the surveys were entirely completed. The completion of the surveys and borings has shown a much larger amount of excavation to be necessary than was expected. The experience of the contractors in building Locks and Dams Nos. 4, 5, and 6 in the same river during the past two seasons has shown the many difficulties and obstacles to be encountered, and that special precaution should be taken to meet them. In view of these facts, and of the possibility that Congress may at this session make an appropriation for this work, it has been deemed advisable to revise the estimates of the cost of Locks and Dams Nos. 1, 2, and 3. These estimates are as follows:

LOCK NO. 1.

Kind of work and material.	Quantity.	Price.	Amount.
Concrete .... cubic yards	12,000	$7.50	$90,000
Excavation .... do	260,000	.35	91,000
Gravel filling .... do	1,000	1.00	1,000
Stone filling .... do	7,000	2.50	17,500
Riprap .... do	4,000	2.50	10,000
Puddling .... do	100	1.50	150
Miter sills .... feet B. M.	4,000	50.00	200
Dam timber .... do	320,000	30.00	9,600
Apron timber .... do	110,000	25.00	2,750

LOCK NO. 1—Continued.

Kind of work and material.	Quantity.	Price.	Amount.
imber ... feet B. M.	116,000	$40.00	$4,640
ing ... do.	20,000	20.00	400
illing ... do.	550,000	40.00	22,000
ation piles ... linear feet.	50,000	.30	15,000
iles ... do.	6,000	.35	2,100
ipe ... do.	500	.50	250
ng and clearing, complete			1,000
ams			10,000
			277,590
se of sites			2,000
alves, and irons			15,000
gs			5,000
ering and incidentals			33,410
otal			333,000

LOCK NO. 2.

te ... cubic yards.	12,000	$7.50	$90,000
tion ... do.	135,000	.35	47,250
filling ... do.	1,000	1.00	1,000
lling ... do.	4,000	2.50	10,000
... do.	2,900	2.50	7,250
ng ... do.	100	1.50	150
lls ... feet B. M.	4,000	50.00	200
mber ... do.	195,000	30.00	5,850
imber ... do.	66,000	25.00	1,650
mber ... do.	116,000	40.00	4,640
ing ... do.	20,000	20.00	400
iling ... do.	465,000	40.00	18,600
tion piles ... linear feet.	48,000	.30	14,400
iles ... do.	6,000	.35	2,100
pe ... do.	500	.50	250
ng and clearing, complete			1,000
ams			8,000
			212,740
se of sites			500
alves, and irons			15,000
gs			5,000
ering and incidentals			26,760
otal			260,000

LOCK NO. 3.

te ... cubic yards.	12,000	$7.50	$90,000
tion ... do.	175,000	.35	61,250
filling ... do.	1,000	1.00	1,000
lling ... do.	3,600	2.50	9,000
... do.	3,600	2.50	9,000
ng ... do.	100	1.50	150
lls ... feet B. M.	4,000	50.00	200
mber ... do.	195,000	30.00	5,850
imber ... do.	66,000	25.00	1,650
mber ... do.	116,000	40.00	4,640
ing ... do.	20,000	20.00	400
iling ... do.	520,000	40.00	20,800
tion piles ... linear feet.	55,000	.30	16,500
iles ... do.	6,000	.35	2,100
pe ... do.	500	.50	250
ng and clearing, complete			1,000
ams			8,000
			231,790
se of sites			500
alves, and irons			15,000
gs			5,000
ering and incidentals			28,710
otal			281,000

RECAPITULATION.

o. 1	$333,000
o. 2	260,000
o. 3	281,000
rand total	874,000

2. Detailed plans for the locks and dams are to be prepared during this winter and spring, but it is believed that these will not show very great differences from the quantities of materials given above. The unit prices given are based on the approximate cost of the work at Locks 4, 5, and 6, and similar work elsewhere. It is believed that if necessity arose the locks and dams could be constructed by the United States with hired labor within the amounts estimated. In view of the many known difficulties which the present contractors have met with, it does not seem probable that contracts can be made at as favorable prices for the new locks and dams.

Very respectfully, your obedient servant,

SPENCER COSBY,
Captain, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

OFFICE DIVISION ENGINEER, GULF DIVISION,
New Orleans, La., December 14, 1901.

Respectfully forwarded to the Chief of Engineers, United States Army, recommending approval of the within estimates.

H. M. ADAMS,
Lieut. Col., Corps of Engineers,
Division Engineer.

(*b*) TOMBIGBEE RIVER FROM THE MOUTH TO DEMOPOLIS.

* * * * * * *

During the past fiscal year the sum of $557.47, the balance remaining from the regular appropriation for this improvement, has been expended in the preservation and care of public property.

* * * * * * *

A survey to determine the location of the necessary lock sites on the Tombigbee River between Demopolis and McGrews shoals is provided for in the recent river and harbor act in the appropriation for improving the Black Warrior, the Warrior, and the Tombigbee rivers, Alabama.

Money statement.

July 1, 1901, balance unexpended		$557.47
Amount appropriated by river and harbor act approved June 13, 1902		20,000.00
		20,557.47
June 30, 1902, amount expended during fiscal year		557.47
July 1, 1902, balance unexpended		20,000.00
Amount (estimated) required for completion of existing project		600,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$250,000.00	
For maintenance of improvement	30,000.00	
		280,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

By act of—		
September 19, 1890		$55,000.00
July 13, 1892		125,000.00
August 18, 1894		75,000.00
June 3, 1896		75,000.00
March 3, 1899		50,000.00
June 13, 1902[a]		20,000.00
Allotted from emergency act of June 6, 1900	$4,000.00	
Less unexpended balance of above allotment turned back into the Treasury	19.19	
		3,980.81
Total		403,980.81

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1901.

Articles.	1901.	
	Tons.	Value.
Cotton	13,375	$2,541,250
Grain	6,000	124,200
Iron	40	1,000
Logs and timber	125,000	750,000
Hard wood and cord wood	40,000	120,000
General merchandise	36,000	360,000
Total	220,415	3,896,450

(*c*) TOMBIGBEE RIVER FROM DEMOPOLIS TO COLUMBUS.

An account of the original condition of this section of the river is contained in the Annual Report of the Chief of Engineers for 1896, page 1443, and a description of the work accomplished prior to June 30, 1900, is contained in the Annual Report of the Chief of Engineers for 1899, page 1712.

* * * * * * *

During the past fiscal year no work toward improving this section of the stream has been accomplished, expenditures being confined to the care and preservation of public property. In May and June, 1902, under authority of the Chief of Engineers dated March 17, 1902, the snag boat *Demopolis* was thoroughly repaired at a total cost of about $1,800 to fit it for work on the improvement.

Money statement.

July 1, 1901, balance unexpended	$16,107.27
June 30, 1902, amount expended during fiscal year	3,564.16
July 1, 1902, balance unexpended	12,543.11
July 1, 1902, outstanding liabilities	1,620.00
July 1, 1902, balance available	10,923.11
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	20,000.00

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[a] Of this appropriation $4,000 is available for improvement of the river between Columbus and Walkers Bridge, Miss.

APPROPRIATIONS.

By act of—		By act of—	
September 19, 1890	$15,000	March 3, 1899	$10,00
July 13, 1892	35,000		
August 18, 1894	50,000	Total	160,00
June 3, 1896	50,000		

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1901.

Articles.	1901.	
	Tons.	Value.
Cotton seed	2,000	$120,00
Grain	400	8,40
Merchandise	620	31,00
Cotton	2,000	380,00
Provisions	35	92
Logs and timber	40,000	240,00
Total	45,055	780,32

(*d*) TOMBIGBEE RIVER FROM FULTON TO COLUMBUS.

An account of the original condition of this work is contained in the Annual Report of the Chief of Engineers for 1893, page 1760. A description of the work done prior to June 30, 1901, is contained in the Annual Reports of the Chief of Engineers for 1900, page 2206, and 1901, page 1837.

* * * During the past fiscal year no work has been accomplished, and the small balance of $210.88, unexpended on July 1, 1901, has been expended during the year in the preservation and care of public property.

High-water navigation has been maintained in accordance with the project, but this section of the Tombigbee River is at present in need of improvement, as a number of obstructions have lodged in the channel since the suspension of operations in September, 1900.

The river and harbor act approved June 13, 1902, appropriated $20,000 for the improvement of the Tombigbee River from the mouth to Demopolis, with the provision that $4,000 of this amount may, in the discretion of the Secretary of War, be expended between Columbus and Walkers Bridge. It is proposed to apply a portion of this allotment of $4,000 to the removal of obstructions existing in the stream between Fulton and Columbus.

Money statement.

July 1, 1901, balance unexpended	$210.8
June 30, 1902, amount expended during fiscal year	210.8
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	10,000.0

APPROPRIATIONS.

By act of—	
July 13, 1892	$6,000
August 18, 1894	4,000
June 3, 1896	8,000
March 3, 1899	5,000
Total	[a]23,000

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1901.

Articles.	1901.	
	Tons.	Value.
Logs and timber	37,500	$225,000

(*e*) TOMBIGBEE RIVER FROM WALKERS BRIDGE TO FULTON.

An account of this improvement is contained in the Annual Reports of the Chief of Engineers for 1889, page 1438, and for 1896, page 1446. * * * No work has been done during the past fiscal year, as no funds were available, and the condition of the improvement on June 30, 1902, was therefore not as good as it should be. This part of the Tombigbee River is much used for rafting logs and timber, and its availability for high-water navigation should be maintained.

* * * * * * *

No commercial statistics could be obtained for this improvement.

Money statement.

July 1, 1901, balance unexpended	$57.51
June 30, 1902, amount expended during fiscal year	57.51
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	3,000.00

APPROPRIATIONS.

By act of—	
August 11, 1888	$4,000
September 19, 1890	4,000
July 13, 1892 (maintenance)	3,000
August 18, 1894 (maintenance)	1,000
By act of—	
June 3, 1896 (maintenance)	$1,000
March 3, 1899 (maintenance)	1,000
Total	[a]14,000

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[a] The sum of $4,000 is made available by the river and harbor act approved June 13, 1902, for the improvement of the Tombigbee River between Columbus and Walkers Bridge, Miss.

S 4.

OPERATING AND CARE OF LOCKS AND DAMS ON BLACK WARRIOR RIVER, ALABAMA.

* * * The locks were closed to navigation as follows:

Lock 1.—August 13, 1901, to October 9, 1901, inclusive, 58 days, for repairs; October 29, 1901, to November 22, 1901, inclusive, 25 days, for repairs; April 16, 1902, 1 day, gates fouled by flood deposit; a total of 84 days.

Lock 2.—July 18, 1901, to August 20, 1901, inclusive, 34 days, for repairs.

Lock 3.—July 17, 1901, to August 5, 1901, inclusive, 20 days, for repairs; December 16, 1901, to December 18, 1901, inclusive, 3 days, approach blocked by drift; April 4, 1902, 1 day, gates fouled by flood deposit; a total of 24 days.

ACCIDENT TO GATE AT LOCK 1.

During the night of September 17, 1901, while the gates at Lock 1 were lashed open in order to drain the pool above through the lock, a sudden rise occurred and tore the upper bank wall gate from its lashings. The gate swung to with such great force that it was badly warped and the cast-iron heel post was cracked in several places. The gate was taken down, rebuilt at the Tuscaloosa shops, and re-erected in place, a new heel post being purchased and substituted for the broken one; the work was finished on November 16, 1901.

GUARD CRIB EXTENSION.

In view of the loss of the towboat *Daisy* by going over Dam No. 2, described on page 1821 of the Annual Report of the Chief of Engineers for 1901, a special allotment was made for additional guard crib protection above the lock. This work was begun late in November and finished early in June. Two cribs were built at Lock 1, two at Lock 2, and four at Lock 3. They flare from the river lock walls at angles of from 5 to 15 degrees, are about level on top with the coping of the lock, and extend protection from 280 to 290 feet above the lock walls. The cribs are 12 by 24 feet in plan. Gaps of 66 feet were left between cribs at Locks 1 and 2 and of 21 feet at Lock 3, for the passage of drift. A drift boom also was built and moored above Lock 3 to assist in warding off drift.

WORK OF THE PAST YEAR.

At Lock 1 valves were repaired and iron steps and gauges were placed. Needle dam trestles and lock gates injured by floods were taken down, repaired, and reerected. Upper lock gates were painted and flood deposit was partially removed from the lock chamber. Repairs to retaining wall at lower end of lock, involving a permanent arrangement for coffer timbers, were finished. Lock house and fencing were repaired and painted.

At Lock 2 valves were repaired and iron steps and gauges placed. Flood deposit was partially removed from lock and approaches. A depression in the bank near the lower end of the lock was filled with earth, and riprap protection was extended to the top of the bank for the full length of the lock, 721 cubic yards of earth and 279 cubic yards of riprap being thus placed. Lock house and fencing were repaired and painted.

At Lock 3 valves were repaired and iron steps placed. Flood deposit was partially removed from the lock chamber. Lock house and fencing were repaired and painted.

NEW BARGES.

Materials have been ordered and are partly delivered for four new wooden deck barges, each 24 feet by 90 feet and 5 feet deep. They are intended for miscellaneous use and are to be built with hired labor during the summer and fall of 1902.

NEED OF A DREDGE.

The lock approaches are gradually silting up and every flood adds to the deposit in lock chambers and lower bays. The removal of this deposit is now very tedious and costly, owing to lack of suitable machinery. The locks are sometimes thrown out of use for several days at a time by flood deposit fouling the gates, and there is no means of removing it promptly. It is never thoroughly removed from the lower bay after a flood until, with a falling river, sufficient head is developed by the dam to enable the culvert scour to wash the deposit away, and then it fans out in the lower approach and reduces the navigable depth. The sum of $5,000 is included in the estimate of allotment needed for operating and care of these locks during the next fiscal year. It is proposed to use a part of this sum for building a barge and equipping it with a centrifugal sand pump and boiler to be used in removing such deposits.

Statement of expenditures for operating and caring for Locks 1, 2, and 3, Black Warrior River, Alabama, during the fiscal year ending June 30, 1902, submitted in accordance with circular No. 12, Office of the Chief of Engineers, dated July 31, 1897:

Items.	Allotted.	Expended.	Balance.	Minus balance.
Salaries of lockmaster and lockmen	$3,800.00	$3,182.00	$618.00	
Extra labor	500.00	500.00		
Riprap bank protection	500.00	424.60	75.40	
Repairing retaining wall and coffer at lower end of Lock 1	1,500.00	869.45	630.55	
Removing flood deposits	500.00	372.11	127.89	
Filling above dams	500.00		500.00	
Repairing and painting fences and buildings	300.00	568.38		$268.38
Grading grounds at Lock 2	400.00	360.75	39.25	
Placing iron steps	100.00	49.80	50.20	
Fuel, lights, and oil	100.00	52.22	47.78	
Tools	100.00	1.78	98.22	
Telephone service (maintenance)	75.00	36.00	39.00	
Incidentals	500.00	1,968.55		1,468.55
Amount required to pay outstanding liabilities	378.00	378.00		
Repair and extension of guard cribs	12,000.00	7,654.23	4,345.77	
Total	21,253.00	16,417.87	6,572.06	1,736.93

Money statement.

July 1, 1902, balance unexpended	$3,190.75
Amount allotted during fiscal year	18,062.25
	21,253.00
June 30, 1902, amount expended during fiscal year	16,417.87
July 1, 1902, balance unexpended	4,835.13
July 1, 1902, outstanding liabilities	3,900.00
July 1, 1902, balance available	935.13

COMMERCIAL STATISTICS

Traffic

Vessels, etc.	Lock No. 1.			Lock No. 2.			Lock No. 3.		
	Ascending.	Descending.	Total.	Ascending.	Descending.	Total.	Ascending.	Descending.	Total.
Passenger boats	1	1	2	6	7	13	17	18	35
Towboats	24	23	47	121	116	237	210	207	417
Government boats	6	4	10	7	6	13	10	9	19
Coal barges					1	1		3	3
Other barges	40	45	85	78	74	152	206	207	413
Government barges	24	22	46	61	54	115	65	62	127
Government small craft	3	10	13	82	75	157	77	74	151
Small craft	13	11	24	17	12	29	34	29	63
Rafts	1	2	3	1	4	5	1	4	5
Total	112	118	230	373	349	722	620	613	1,233
Passengers				229	265	494	330	498	828
Lockages	58	60	118	233	222	455	331	329	660

Commerce.

[In tons.]

Lock and date.	Coal.	Stone.	Sand.	Lock gates.	Logs.	Lumber.	General and miscellaneous.	Total.
LOCK NO. 1.								
July, 1901						245		245
August, 1901						280		280
September, 1901								
October, 1901								
November, 1901			15					15
December, 1901			30					30
January, 1902		669					50	719
February, 1902		1,447			87			1,534
March, 1902	200	1,142						1,342
April, 1902	40	320		180				540
May, 1902		360					25	385
June, 1902								
Total	240	3,938	45	180	87	525	75	5,090
LOCK NO. 2.								
July, 1901	15					245	20	280
August, 1901						490	1	491
September, 1901		40				70	2	112
October, 1901	70						1	71
November, 1901			15					15
December, 1901			30					30
January, 1902	60	1,265					50	1,375
February, 1902		1,990			87			2,077
March, 1902	200	1,697					1	1,898
April, 1902	75	568					7	650
May, 1902		760					42	802
June, 1902	30						33	63
Total	450	6,320	45		87	805	157	7,864
LOCK NO. 3.								
July, 1901	15		132			245	20	412
August, 1901			57			490	1	548
September, 1901			179			70	5	254
October, 1901	70		131				2	203
November, 1901			167				4	171
December, 1901			75				1	76
January, 1902	60	1,372	82				51	1,565
February, 1902		2,512	44		87		4	2,647
March, 1902	215	2,947	59				1	3,222
April, 1902	235	1,833	174				8	2,250
May, 1902		650	332				39	1,021
June, 1902	30		387				34	451
Total	625	9,314	1,819		87	805	170	12,820

Comparative table of commerce through locks.

LOCK NO. 1.

Items.	Fiscal year ending June 30— 1897.	1898.	1899.	1900.	1901.	1902.
VESSELS.						
boats ... number	67	233	172	71	94	59
s ... do	89	403	118	87	180	131
boats ... tonnage	(a)	6,165	3,655	1,892	3,135	3,621
s ... do	(a)	29,032	5,770	5,465	19,265	12,884
ıgers ... number	58	203	348	36	28	
ges ... do	228	537	220	119	199	118
FREIGHT CARRIED.						
... tons	1,925	2,223	1,059	615	3,305	240
... do					12	
ı ... do				38		
... do					10	
·ails ... do				28		
ıt ... do			88	22		
... do		5,076			2,082	3,938
... do		148			128	45
... do					18	
ties ... do		113				
timber ... do		5,264				
... do	149	4	342	138		87
er ... do	81	352	182	596	1,701	525
al and miscellaneous ... do	14	111	90	219	293	255
Total	2,169	13,291	1,761	1,656	7,549	5,090

LOCK NO. 2.

Items.	1897.	1898.	1899.	1900.	1901.	1902.
VESSELS.						
boats ... number	294	633	297	104	371	263
s ... do	235	439	147	105	162	268
boats ... tonnage	(a)	13,985	6,431	2,657	9,111	8,708
s ... do	(a)	33,590	7,800	6,750	21,479	24,312
ıgers ... number	1,342	2,994	721	71	1,275	494
ges ... do	584	774	354	208	506	455
FREIGHT CARRIED.						
... tons	4,706	4,139	1,269	707	3,945	450
... do		25			12	
ı ... do				38		
... do					10	
·ails ... do		22		20		
ıt ... do		9	88	22		
... do		5,210			1,277	6,320
... do		148			68	45
... do					18	
... do		14				
ties ... do		113				
timber ... do		5,527				
... do	165	16	392	138		87
er ... do	146	514	346	626	1,713	805
al and miscellaneous ... do	44	320	110	285	430	157
Total	5,061	16,057	2,205	1,836	7,473	7,864

LOCK NO. 3.

Items.	1897.	1898.	1899.	1900.	1901.	1902.
VESSELS.						
boats ... number	309	636	308	111	473	471
s ... do	211	474	151	110	271	543
boats ... tonnage	(a)	13,582	6,729	2,948	11,635	13,987
s ... do	(a)	35,790	8,060	7,020	28,430	38,942
ıgers ... number	1,538	3,089	732	111	1,482	828
ges ... do	551	815	372	228	614	660
FREIGHT CARRIED.						
... tons	4,699	4,618	1,456	757	4,255	625
... do		25			12	
ı ... do				38		

(a) No record kept.

Comparative table of commerce through locks—Continued.

LOCK NO. 3—Continued.

Items.		Fiscal year ending June 30—				
	1897.	1898.	1899.	1900.	1901.	1
Hay .... tons..	....	....	....	....	10	..
Steel rails .... do....	....	22	....	20	....	..
Cement .... do....	....	9	88	22	....	..
Stone .... do....	....	5,290	....	....	1,804	
Sand .... do....	....	148	....	....	845	
Oats .... do....	....	....	....	....	18	..
Posts .... do....	....	14	....	....	....	..
Cross-ties .... do....	....	113	....	....	....	..
Hewn timber .... do....	....	5,728	....	....	....	..
Logs .... do....	178	74	332	138	....	
Lumber .... do....	139	514	346	626	1,718	
General and miscellaneous .... do....	44	320	110	285	487	
Total	5,060	16,875	2,332	1,886	9,149	

S 5.

IMPROVEMENT OF NOXUBEE RIVER, MISSISSIPPI.

* * * * * * *

No work in connection with this improvement has been accompli
during the past fiscal year and no expenditures have been made.
condition of the river on June 30, 1900, was such as to permit of
navigation from the mouth to State line, Miss., on a 6-foot stage,
from thence to Macon, Miss., during higher stages, although m
obstructions have lodged in the river since the suspension of op
tions in November, 1899. The total amount expended on this impr
ment to June 30, 1902, is $62,000.

* * * * * * *

No commercial statistics could be obtained for this improvement.

Money statement.

Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	$3,0
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

By act of—		By act of—	
June 14, 1880	$12,000	September 19, 1890	$
March 3, 1881	8,000	July 13, 1892 (maintenance).	
August 2, 1882	10,000	August 18, 1894 (maintenance)	
July 5, 1884	7,500	June 3, 1896 (maintenance)..	
August 5, 1886	7,500		
August 11, 1888	5,000	Total	6

S 6.

IMPROVEMENT OF PASCAGOULA RIVER AND HORN ISLAND HARBOR, MISSISSIPPI.

* * * * * * *

During the past fiscal year 66,665 cubic yards of material were removed from Horn Island Harbor under a contract dated July 21, 1899, and contracts supplemental thereto, as well as 322,209 cubic yards from the channel of Pascagoula River. The removal of this material resulted in the widening of the 400-foot channel through the "Bulkhead" shoal, at Horn Island Harbor, to 500 feet over its entire length of 4,000 feet; in the dredging of a 20-foot channel 500 feet wide and about 1,250 feet long through the "Neck," at the same locality; in the widening of the 200-foot channel of Pascagoula River to the full width of 300 feet over its entire length of 17,500 feet, and in the removal of some shoal spots in the channel previously dredged. Work under this contract was completed on February 28, 1902, at which time uninterrupted channels of the full width and depth had been obtained throughout the limits of the project, thereby completing the latter. The total quantities of material dredged from Horn Island Harbor and Pascagoula River under this contract were 233,387 cubic yards and 1,165,233 cubic yards, respectively.

Upon the completion of this improvement the depth in the channel in Pascagoula River was such as to allow coastwise vessels of 12 feet draft to ascend to the lumber mills at Scranton and Moss Point and to load full cargoes there. Previous to the commencement of this improvement such vessels were obliged to lighter a considerable part of their cargoes.

In March and April, 1902, a survey of Pascagoula River within the limits of the project was made in order to furnish information as to the reasonable permanency of a channel in this stream 17 feet deep. The detailed report of Mr. David G. Anderson, assistant engineer, upon this survey is appended.

* * * * * * *

The reference plane of mean low water in use on this improvement up to the completion of work under the last contract has now been lowered 1 foot, to conform to the results of the series of observations made by the Mississippi River Commission.

Money statement.

July 1, 1901, balance unexpended	$128, 892. 61
Amount appropriated by river and harbor act approved June 13, 1902	25, 000. 00
	153, 892. 61
June 30, 1902, amount expended during fiscal year	115, 656. 97
July 1, 1902, balance unexpended	38, 235. 64
Amount (estimated) required for completion of existing project	750, 000. 00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	400, 000. 00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

By act of—

March 3, 1899	$50,000
June 6, 1900	267,600
June 13, 1902	25,000
Total	342,600

COMMERCIAL STATISTICS.

The following statement concerning the clearances from the port of Pascagoula for the calendar year ending December 31, 1901, was furnished by the United States custom-house at Pascagoula, Miss.:

Year.	Clearances.		Net tonnage.	Custom receipts.
	Foreign.	Domestic.		
1901	210	47	144,609	$6,827

The following statement concerning the commerce of the Pascagoula River for the calendar year ending December 31, 1901, was furnished by the Pascagoula Commercial Club, of Scranton, Miss.:

Articles.	1901.	
	Tons.	Value.
ARRIVING.		
Logs and timber	430,000	$1,548,462
Total	430,000	1,548,462
DEPARTING.		
Lumber and timber	202,000	1,664,808
Rosin	6,200	120,000
Turpentine	2,300	200,000
Charcoal	7,200	60,000
Total	217,700	2,044,808

REPORT OF MR. DAVID G. ANDERSON, ASSISTANT ENGINEER.

MOBILE, ALA., *June 30, 1902.*

CAPTAIN: I have the honor to submit the following report upon a survey of Pascagoula and Dog rivers, Mississippi, from a point in the latter stream about 3 miles above its junction with the Pascagoula River to the 17-foot curve of depth in Mississippi Sound. This survey was made in March and April, 1902, at the close of operations under a contract for dredging a 12-foot channel in these streams, in order to determine the condition of the work executed under this contract, and for the further purpose of obtaining information as to the probable permanency of the proposed 17-foot channel between the lumber mills at and above Moss Point and deep water in Mississippi Sound.

Pascagoula River is formed by the junction of the Leaf and Chickasahay rivers, and flows in a southerly direction through the southeastern portion of the State of Mississippi. About 15 miles north of Mississippi Sound the river divides into two branches, known as the East and West Pascagoula rivers, which empty separately into Mississippi Sound at points about 5 miles apart. The former branch, known generally as the Pascagoula River, is the one whose improvement has been in progress, this improvement consisting of the formation of an entrance channel from Mississippi Sound.

At a point about 6¾ miles above its mouth the Pascagoula River is joined on its eastern side by the Dog River, a stream of some size, along the lower portion of which a number of lumber mills are situated. As the existing project for deepening the Pascagoula River includes the formation of a similar channel in the lower 3 miles of the Dog River, the present survey included the channel of the latter river for a distance 3¼ miles above its mouth, as well as the channel of the Pascagoula River from the mouth of Dog River to Mississippi Sound, a distance of 6¾ miles, and the entrance channel from Mississippi Sound to the Pascagoula River, a distance of 5¾ miles, or a total distance of over 15 miles.

The method adopted for the survey was that of a stadia traverse. In the river proper both shore lines and soundings were located entirely by the stadia, while at the mouth the method was necessarily modified somewhat in order to meet the conditions existing in that locality.

The history of the improvement of the lower portion of the Pascagoula River is as follows:

The river and harbor act approved March 3, 1873, provided for a survey of the Pascagoula River with a view to the preparation of a project for its improvement. The survey was made at that time, but no work toward improvement was commenced. The river and harbor act of 1878 appropriated $10,000 for the improvement of the Pascagoula River, and under this appropriation another examination was made and a project submitted for the formation of a channel 7 feet deep at mean low water across the bar at the mouth of the river, the width of this channel to be 200 feet. The original depth of water across this bar was from 3 to 3½ feet, and in winter time when the tide was low it was frequently necessary for the lumber lighters to unload their cargoes, float the lumber across the bar, and reload on the outside.

Under the appropriations made between 1878 and 1882 a channel from 7½ to 8 feet deep and from 180 to 190 feet wide was dredged over the bar at the mouth of the river, enabling vessels to ascend the river to the lumber mills at Moss Point and load to this draft, thus saving lighterage bills and claims for demurrage.

In 1886 a new project for this improvement was submitted, which contemplated the formation of a channel of navigable width, with a depth of 12 feet, from Moss Point to the anchorage basin in Mississippi Sound, the estimated cost of this channel being $78,100. Under the new project the first contract was directed toward deepening the cut at the mouth of the river. This work was performed in 1887 and 1888, and a channel of navigable width and 9½ feet deep was obtained. Under subsequent contracts a channel 80 feet wide and 12 feet deep was formed between Moss Point and the mouth of the river, and a channel 12 feet deep and from 80 to 120 feet wide was dredged for a portion of the distance across the bar at the mouth of the stream.

The river and harbor act of June 3, 1896, provided for a survey of Pascagoula River with a view to obtaining a channel 17 feet deep at mean low tide from the 17-foot contour in Mississippi Sound to a point in Dog River 3 miles above its junction with the Pascagoula River. The existing project for the improvement is based on the survey made in compliance with the requirements of the act of 1896, and provides for first obtaining a channel 12 feet deep within the limits of the project, this depth to be increased subsequently to 17 feet if the 12-foot channel is found to be reasonably permanent.

Work under the 12-foot project was in progress between September 28, 1899, and February 28, 1902, under a contract with Mr. Albert G. Delmas, of Scranton, Miss. Under this contract a channel was dredged 12 feet deep and 150 feet wide from the upper limit of the project in Dog River to the railroad bridge in Scranton, and a channel of the same depth and 300 feet in width was formed between the railroad bridge in Scranton and the 12-foot contour in Mississippi Sound. The work in the river was executed by a hydraulic dredge, which commenced operations at Dog Island in September, 1899, and completed the channel to a point just beyond Pascagoula light-house in January, 1901. The channel in Mississippi Sound between the latter point and the 12-foot contour was dredged by clamshell machines between June, 1900, and February, 1902.

The lower portion of Dog River flows in a generally westerly direction. The Pascagoula River, below the mouth of Dog River, flows through a curve of 180° from a westerly to an easterly direction, and then making a right-angle bend flows in a generally southerly direction to its mouth. At the mouth of the river the dredged channel bends through an angle of 60°, the cut in Mississippi Sound being toward the southeast. The winds in this locality, which have considerable effect on the currents, are most frequently southeast in summer and from north to northwest in winter, and the first cut dredged at the mouth of the river was made in a southeasterly direction so as to coincide as nearly as possible with the direction of the prevailing currents. The original location for the channel of approach in Mississippi Sound has been retained, the first cut having been widened, deepened, and lengthened from time to time.

The banks of the Dog and Pascagoula rivers, within the limits of the survey, are mostly marsh lands, and during storm tides are overflowed, except at Moss Point and Scranton, where the streams are bordered by fast land. In common with streams flowing through marshes, the Pascagoula and Dog rivers have a great number of tributaries. These tributaries are bayous and lakes, the former ramifying through the marshes and forming separate outlets into Mississippi Sound and into the West Pascagoula River, while the latter, which are often of considerable area, are used by the lumber mills for the storage of large quantities of logs which are received for manufacture into lumber.

The natural flow of ebb and flood currents in Pascagoula and Dog rivers is very much complicated and interfered with by the existence of these tributary bayous and lakes. Very frequently the entrances to these tributary bayous and lakes are located at points where the channel of the river makes a sharp bend, so that the prolongation of the line of the river passes into the tributary, thereby perceptibly diverting and affecting the river currents, often to the detriment of the channel. In this manner flood-tide pockets lead into Crooked Bayou, into the lake back of Dog Island, into the lake back of Robertson's mill, and into the lake back of Denny's upper mill, while the ebb currents tend to flow through Bayou Chammier, Bayou McEnnis, and Delmas Bayou. In almost every one of the localities mentioned the diversion of the current from the main stream appears to cause the formation of a shoal in the channel. Bayou Chammier forms an auxiliary path for the flood and ebb currents between Mississippi Sound and the Upper Pascagoula River, and under certain conditions the flood current passes into the Upper Pascagoula River through this bayou, while at times, during ebb tide, a considerable portion of the current is diverted through this bayou into West Pascagoula River without having passed through the lower reaches of the East Pascagoula River or across the bar at the mouth of the latter stream. The change in the regimen of this stream in the vicinity of Bayou Chamier is indicated by the fact that while the cross section of the river just below the mouth of this bayou is 6,223 square feet, the cross section above the bayou is 9,779 square feet.

The following table illustrates the physical characteristics of the Dog and Pascagoula rivers within the limits of the survey, and shows that the regimen of these streams is extremely irregular:

No. of cross section.	Approximate location above Pascagoula light.	Cross section.	Width of cross section.	Maximum depth of section.	Mean depth of section.	Locality.
Pascagoula River:	*Miles.*	*Sq. feet.*				
1	0	7,974	1,000	[a]12.9	8.0	Opposite light-house.
2	0¾	7,595	890	[a]12.3	8.5	Delmas Flats.
3	1¼	9,878	640	27.2	15.4	Railroad bridge.
4	2¼	7,465	900	14.5	8.3	Krebs Lake.
5	3	8,078	450	49.0	18.0	Opposite Bayou McEnnis.
6	4	6,223	550	28.4	11.8	Below Bayou Chammier.
7	5	9,779	1,290	[a]12.5	7.6	Lowery Island Flats.
8	6	9,274	800	22.7	11.6	Just below Crooked Bayou.
Dog River.						
9	6½	9,012	620	22.6	14.5	Just below Dog River.
10	6¾	8,489	440	28.9	19.3	Just above mouth of Dog River.
11	7¾	8,009	450	25.3	17.8	Randalls Ferry.
12	8¼	4,139	360	15.5	11.5	Opposite Robinson's mill.
13	8¾	4,917	260	34.8	18.9	Opposite Denny's upper mill.
14	9¾	5,852	300	44.3	19.5	Below White's mill.

[a] In dredged cut.

The localities at which dredging was required in order to form the 12-foot channel in accordance with the project and the probable cause of shoals at these points are as follows:

Locality.	Cause of shoal.
Dog Island	Extensive opening into lake back of Dog Island causes dispersion of the current, followed by a checking of its velocity. Flood-tide pocket heads into this lake, showing the deflection of current.
Lowery Island	The river below Crooked Bayou possesses abnormal width and an abnormally large cross section. The resulting diminution of velocity causes shoal.
Belle Fontaine Bayou	Currents of stream interfered with by opening into Krebs Lake, the bend in the river at this locality, and excessive width of cross section.
Below railroad bridge to 12-foot contour in Mississippi Sound.	The upper portion of this shoal reach is apparently caused by this locality being the point of meeting of the flood tide from the sound and the fresh-water discharge at high stages of the river. The remainder of this shoal is across the natural bottom of Mississippi Sound, the slope of which is very flat.

The records of the examination made during the progress of the Pascagoula contract and the results of the present survey show, as far as can be ascertained, that the only shoaling due to natural causes since the commencement of dredging operations in 1899 has been at the lower end of the channel at Lowery Island and on the eastern side of the channel just outside the mouth of the river. The former shoal was evidently caused by the currents being concentrated near the western bank of the river, owing to the bend just above, while the latter was apparently caused by the westerly littoral drift along the shore of Mississippi Sound. Several other shoals were formed during the progress of the work by tugboats releasing vessels which had grounded on the sides of the cut.

The additional localities requiring dredging to obtain the 17-foot channel are as follows:

Locality.	Cause of shoal.
Opposite mouth of bayou above Denny's upper mill.	Dispersion and deflection of currents.
Opposite Robertson's mill....	Uncertain.
Opposite mouth of Crooked Bayou.	Division of current and deflection into bayou.
Opposite Bayou Chammier...	Conflict and division of currents.
Opposite Krebs Lake.........	Extension of Belle Fontaine Bayou shoal due to excessive width of the river, the opening into Krebs Lake, and bend in stream.

An examination of the map shows that the 17-foot depths are much more frequent in the upper portions of the streams covered by this survey than in the lower. This fact is due, apparently, to the greater number of bends which occur in the upper reaches of the rivers, thereby causing deep water by the concentration of the currents on the concave banks. The estimated quantity of material to be removed in order to complete the 17-foot channel within the limits of the project is 3,600,000 cubic yards, scow measurement.

That the proposed 17-foot channel will be absolutely permanent is beyond the range of probability. In the river itself the currents are deflected and divided by the tributary bayous and lakes in such a manner as to make shoaling almost certain, while in Mississippi Sound the channel is exposed to the littoral drift along the shore and the action of storms. As the tributary lakes and bayous are used for navigation and rafting, they can not be closed up entirely, but it is believed that after a careful consideration of the problem regulating works can be designed which would greatly improve the possibility of maintaining the dredged channel. In the sound, while a short dike could be constructed on the west side of the channel at the mouth of the river which would make this portion of the dredged cut fairly permanent, any extensive protection is impracticable owing to the great length of the dredged cut, and the channel must therefore always be subjected to shoaling, which will be changeable in its rate according to the prevailing weather conditions.

In view of the fact that the commerce of the Pascagoula River has increased to a great extent on account of the formation of a 12-foot channel, while a still greater increase must follow the dredging of a 17-foot channel, and in view of the fact that the amount of shoaling in the existing channel, and the consequent cost of its maintenance, will probably be comparatively small, I am of the opinion that the 12-foot channel can be considered reasonably permanent, and that the undertaking of the formation of a 17-foot channel by the Government is justified by the prospective commerce involved.

Respectfully submitted.

David G. Anderson,
Assistant Engineer.

Capt. Spencer Cosby,
Corps of Engineers.

S 7.

IMPROVEMENT OF PASCAGOULA RIVER, MISSISSIPPI.

* * * * * * *

During the past fiscal year no work has been performed under this project, as no funds were available therefor. The present condition of Pascagoula River will permit of its navigation by vessels of 6½ feet draft up to Cedar Creek, 55 miles above its mouth, througho year, and thence to its head, at the junction of Leaf and Chicka rivers, on a 6-foot rise above low water. The channel is, how more or less obstructed by logs and snags which have accum since the last work was performed.

* * * * * *

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902 ..	[a] $4,
July 1, 1902, balance unexpended	4,
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	5,

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

APPROPRIATIONS.

By act of—		By act of—	
March 2, 1827	$8,000	August 11, 1888	$
May 23, 1828	17,500	September 19, 1890	
August 30, 1852	5,000	July 13, 1892	
June 17, 1878	10,000	August 18, 1894	
March 3, 1879	14,000	June 3, 1896	
June 14, 1880	20,000	June 13, 1902 (allotment)..	
March 3, 1881	4,000		
August 2, 1882	8,000	Total	2
July 5, 1884	3,000		
August 5, 1886	20,000		
August 5, 1886, transferred amount appropriated for improving Horn Island Pass, act of July 5, 1884..	5,000		

COMMERCIAL STATISTICS.

For commercial statistics, see those furnished by the Pascagoula Comn Club, of Scranton, Miss., in report on Pascagoula River and Horn Island H Mississippi.

S 8.

IMPROVEMENT OF CHICKASAHAY RIVER, MISSISSIPPI.

An account of this improvement is contained in the Annual Re of the Chief of Engineers for 1896 and 1900, pages 1452 and respectively.

* * * * * *

Since the suspension of operations in September, 1899, many snags, and other obstructions have lodged in the channel. Durin fiscal year ending June 30, 1902, no work was in progress in co tion with this improvement on account of the exhaustion of ava funds, the small balance of $49.93, unexpended on July 1, 1901, being expended during the year in the preservation and care of public property.

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[a] Allotted from consolidated appropriation for Pascagoula, Chickasahay, an rivers, Mississippi.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$49.93
Amount appropriated by river and harbor act approved June 13, 1902	[a]2,250.00
	2,299.93
June 30, 1902, amount expended during fiscal year	49.93
July 1, 1902, balance unexpended	2,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	5,000.00

APPROPRIATIONS.

By act of—		By act of—	
September 19, 1890	$5,000	March 3, 1899	$2,500
July 13, 1892	5,000	June 13, 1902 (allotment)	[a]2,250
August 18, 1894	5,000		
June 3, 1896	2,000	Total	21,750

COMMERCIAL STATISTICS.

The following statement of the combined commerce of the Chickasahay and Leaf rivers for the calendar year ending December 31, 1901, was furnished by the Pascagoula Commercial Club, of Scranton, Miss.:

Articles.	1901.	
	Tons.	Value.
Logs and timber	293,000	$1,758,000
Turpentine	250	5,000
Rosin	1,000	87,000
General merchandise	500	50,000
Total	294,750	1,900,000

S 9.

IMPROVEMENT OF LEAF RIVER, MISSISSIPPI.

* * * * * * *

During the past fiscal year no work has been done on this improvement, owing to the exhaustion of available funds, the balance of $588.22, unexpended on July 1, 1901, having been expended in the preservation and care of public property.

Since the suspension of operations in September, 1899, the channel of Leaf River has become obstructed by snags and logs, which accumulate after each high water and which should be removed annually. The channel, although somewhat obstructed, is still available for high-water navigation. The total amount expended on the improvement up to June 30, 1902, was $17,500.

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[a] Allotted from consolidated appropriation for Pascagoula, Chickasahay, and Leaf rivers, Mississippi.

* * * * * * *

It is proposed to allot the sum of $2,250 from the appropriation of June 13, 1902, for improving Pascagoula River and its tributaries, the Chickasahay and Leaf rivers, Mississippi, to the work of improving Leaf River by the removal of logs and snags which obstruct the high-water channel at present.

Money statement.

July 1, 1901, balance unexpended	$588.22
Amount appropriated by river and harbor act approved June 13, 1902	[a] 2,250.00
	2,838.22
June 30, 1902, amount expended during fiscal year	588.22
July 1, 1902, balance unexpended	2,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	5,000.00

APPROPRIATIONS.

By act of—	
September 19, 1890	$5,000
July 13, 1892	5,000
August 18, 1894	2,500
June 3, 1896	2,500
March 3, 1899	2,500
June 13, 1902 (allotment)	[a] 2,250
Total	19,750

S 10.

IMPROVEMENT OF HARBOR AT BILOXI, MISSISSIPPI.

* * * * * * *

No work has been done at this locality since August, 1893.

* * * * * * *

APPROPRIATIONS.

By act of—		By act of—	
August 2, 1882	$5,000	June 13, 1902	$10,000
August 5, 1886	12,500		
August 11, 1888	18,500	Total	55,000
September 19, 1890	9,000		

S 11.

CHANNEL FROM GULFPORT TO SHIP ISLAND HARBOR, MISSISSIPPI.

An account of this improvement is contained in the Annual Report of the Chief of Engineers for 1901, page 1846.

* * * * * * *

Dredging at this locality was commenced with a hydraulic dredge in the anchorage basin on April 16, 1901, and on June 3, 1901, a clamshell dredge was placed at work on the channel, another being added in September, 1901. Dredging operations have progressed continuously since the commencement of work, three machines having been generally employed on the work. On June 30, 1902, work under this contract was still in progress.

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[a] Allotted from consolidated appropriation for Pascagoula, Chickasahay, and Leaf rivers, Mississippi.

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The portion of the channel which has been dredged up to the close of the fiscal year ending June 30, 1902, consists of four cuts each 40 feet in width, one immediately to the west and three immediately to the east of the central line or axis of the proposed channel. Each cut has a length of 7.2 miles, beginning at the initial point (the junction of the dredged channel with the anchorage basin), and extending in a southerly direction to the 19-foot curve of depth in Mississippi Sound; that is, a channel has been dredged 160 feet wide and 7 miles 1,133 feet long to an average depth of from 19 to 20 feet at mean low water. Portions of adjacent cuts and a portion of the eastern side of the anchorage basin have also been completed. With the exception of a small portion of the work in the anchorage basin and a cut of short length in the channel, these operations have been performed during the past fiscal year. On June 30, 1902, the depths in the dredged cuts in the channel and anchorage basin varied from 14 to 21 feet, the maximum low-water draft available being 18 feet.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$448.98
June 30, 1902, amount allotted during fiscal year	9,485.04
Amount appropriated by sundry civil act approved June 28, 1902	150,000.00
	159,934.02
June 30, 1902, amount expended during fiscal year	4,971.25
July 1, 1902, balance unexpended	154,962.77
July 1, 1902, outstanding liabilities	540.00
July 1, 1902, balance available	154,422.77

APPROPRIATIONS.

By act of—	
July 5, 1884 (allotments)	$10,485.04
June 28, 1902	150,000.00
Total	160,485.04

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1901.

Articles exported.	1901.	
	Tons.	Value.
Lumber and timber	87,700	$877,000

CONTRACT IN FORCE.

With Spencer S. Bullis, dated February 20, 1901, approved by the Chief of Engineers March 18, 1901, for dredging a channel and anchorage basin in Mississippi Sound between Ship Island Harbor and Gulfport, Miss., for $150,000, and for maintaining said channel and anchorage basin for a period of five years after its completion, for the sum of $10,000 annually. Work commenced April 16, 1901; to be completed by April 15, 1903. Maintenance to commence immediately upon completion of the channel and basin.

Statement of expenditures for examinations and inspections of work of dredging channel from Ship Island Harbor to Gulfport, Miss., during fiscal year ending June 30, 1902, submitted in accordance with Circular No. 12, from office of the Chief of Engineers, dated July 31, 1897.

Items.	Allotted.	Expended.	Balance.
Inspection and superintendence	$7,498.00	$3,841.62	$3,656.38
Examinations and surveys	1,800.00	518.44	1,281.56
Mileage, etc	136.02	111.19	24.83
Office expenses	500.00	500.00	....
Total	9,934.02	4,971.25	4,962.77

S 12.

IMPROVEMENT OF PEARL RIVER BELOW ROCKPORT, MISSISSIPPI.

* * * * * * *

No work in connection with this improvement was performed during the past fiscal year, operations having been suspended in June, 1900, on account of exhaustion of available funds. The small balance of $648.60, unexpended on July 1, 1901, was applied to the preservation and care of public property.

On June 30, 1900, the river was navigable at low water for vessels of 3 feet draft from the mouth to Monticello, Miss., a distance of 212 miles. Between the latter point and Rockport the channel could be navigated only on a 6 or 7 foot rise. Since the suspension of operations numerous obstructions have accumulated in the channel, thereby injuring it to some extent.

During recent years the improvement of this part of Pearl River has been limited to the 116 miles between the head of Holmes Bayou and Monticello. The 51 miles of river below the head of Holmes Bayou to the mouth of West Pearl River is in need of considerable improvement, particularly the channel through Holmes Bayou, which is quite narrow and very much obstructed.

* * * * * * *

The total amount expended on this work of improvement to June 30, 1902, is $155,125.

Money statement.

July 1, 1901, balance unexpended		$648.60
Amount appropriated by river and harbor act approved June 13, 1902		7,000.00
		7,648.60
June 30, 1902, amount expended during fiscal year		648.60
July 1, 1902, balance unexpended		7,000.00
Amount (estimated) required for completion of existing project		33,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$10,000.00	
For maintenance of improvement	7,000.00	
		17,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

By act of—		By act of—	
June 14, 1880	$30,000	July 13, 1892	$15,000
March 3, 1881	25,000	August 18, 1894	5,000
August 2, 1882	15,000	June 3, 1896	10,000
July 5, 1884	10,000	March 3, 1899	7,000
August 5, 1886	13,125	June 13, 1902	7,000
August 11, 1888	10,000		
September 19, 1890	15,000	Total	162,125

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1901.

[Approximate.]

Articles.	1901.	
	Tons.	Value.
Logs and timber	190,000	$950,000
Turpentine, rosin, and general merchandise	3,000	60,000
Total	193,000	1,010,000

S 13.

IMPROVEMENT OF PEARL RIVER BETWEEN CARTHAGE AND JACKSON, MISSISSIPPI.

* * * * * * *

Work during the past fiscal year has been confined entirely to the care and preservation of public property, and the small balance of $127.75, available on July 1, 1901, was expended during the year for this purpose.

* * * * * * *

No commercial statistics could be obtained for this improvement.

Money statement.

July 1, 1901, balance unexpended	$127.75
Amount appropriated by river and harbor act approved June 13, 1902	[a]3,000.00
	3,127.75
June 30, 1902, amount expended during fiscal year	127.75
July 1, 1902, balance unexpended	3,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	6,000.00

APPROPRIATIONS.

By act of—		By act of—	
March 3, 1879	$6,000	July 13, 1892	$5,000
June 14, 1880	7,500	August 18, 1894	2,400
March 3, 1881	2,500	June 3, 1896	2,400
August 2, 1882	2,500	March 3, 1899	2,500
August 6, 1886	2,250	June 13, 1902	[a]3,000
August 11, 1888	2,500		
September 19, 1890	3,000	Total	41,550

---

[a] For expenditure between Edinburg and Jackson.

S 14.

IMPROVEMENT OF PEARL RIVER BETWEEN EDINBURG AND CARTHAGE, MISSISSIPPI.

* * * * * * *

During the past fiscal year, no funds being available for this work, no work was done and no expenditures were incurred.

* * * * * * *

Money statement.

Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	$1,000.00

APPROPRIATIONS.

By act of—	
July 5, 1884	$2,500
August 5, 1886	2,250
August 11, 1888	5,000
September 19, 1890	5,000
July 13, 1892 (maintenance)	500
August 18, 1894 (maintenance)	$500
June 3, 1896 (maintenance)	500
March 3, 1899 (maintenance)	1,000
Total	[a]17,250

COMMERCIAL STATISTICS.

Considerable rafting is done on this portion of Pearl River, but no statistics as to quantities were obtainable.

S 15.

IMPROVEMENT OF BOGUE CHITTO, LOUISIANA.

* * * * * * *

No work has been done in connection with this improvement during the past year, and no expenditures were incurred.

The river has been improved as far as Cross River, about 80 miles above the mouth. Above this point no work has been accomplished, and this portion of the stream can be navigated only during high water.

* * * * * * *

APPROPRIATIONS.

By act of—	
September 19, 1890	$5,000
July 13, 1892	5,000
August 18, 1894	5,000
June 3, 1896	5,000
March 3, 1899	$5,000
Total	25,000

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1901.

[Approximate.]

Articles.	1901.	
	Tons.	Value.
Logs and timber	30,000	$180,000

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[a] See appropriations for Pearl River between Carthage and Jackson.

APPENDIX T.

IMPROVEMENT OF HOMOCHITTO RIVER, MISSISSIPPI, AND OF RIVERS AND HARBORS IN SOUTHERN LOUISIANA AND EASTERN TEXAS.

REPORT OF LIEUT. COL. H. M. ADAMS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Homochitto River, Mississippi.
2. Chefuncte River and Bogue Falia, Louisiana.
3. Tickfaw River and its tributaries, Louisiana.
4. Amite River and Bayou Manchac, Louisiana.
5. Closing crevasse in Pass a Loutre, Mississippi River.
6. Outlet of Mississippi River.
7. Maintenance of South Pass, Mississippi River.
8. Bayou Lafourche, Louisiana.
9. Bayou Plaquemine, Grand River, and Pigeon Bayous, Louisiana.
10. Bayou Courtableau, Louisiana.
11. Bayou Teche, Louisiana.
12. Channel, bay, and passes of Bayou Vermilion, Louisiana.
13. Mermentau River and tributaries, Louisiana.
14. Mouth and passes of Calcasieu River, Louisiana.
15. Johnsons Bayou, Louisiana.
16. Removing water hyacinths from Louisiana waters.
17. Mouths of Sabine and Neches rivers, Texas.
18. Sabine River, Texas.
19. Harbor at Sabine Pass, Texas.

United States Engineer Office,
New Orleans, La., July 18, 1902.

General: I have the honor to submit herewith annual report upon works of river and harbor improvement in this district, for the fiscal year ending June 30, 1902, as follows:

* * * * * * *

Very respectfully, your obedient servant,

H. M. Adams,
Lieut. Col., Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

T 1.

IMPROVEMENT OF HOMOCHITTO RIVER, MISSISSIPPI.

* * * * * * *

An examination in February, 1902, showed that obstructions had again formed in that portion of the river which had been improved. It is proposed to remove these obstructions with the available funds.

Money statement.

July 1, 1901, balance unexpended	$584.28
Amount appropriated by river and harbor act approved June 13, 1902	2,000.00
	2,584.28
June 30, 1902, amount expended during fiscal year	62.68
July 1, 1902, balance unexpended	2,521.60

ABSTRACT OF APPROPRIATIONS FOR IMPROVING HOMOCHITTO RIVER, MISSISSIPPI.

By act of Congress approved March 3, 1899	$16,000
By act of Congress approved June 13, 1902 (maintenance)	2,000
Total	18,000

COMMERCIAL STATISTICS.

[From January 1, 1901, to December 31, 1901.]

Vessels entering and departing.

Class.	Number.	Trips.	Net registered tonnage.
Steamers	2	4	223

Shipments by water.

Article.	Tons.	Value.
Cotton seed	800	$13,600

T 2.

IMPROVEMENT OF CHEFUNCTE RIVER AND BOGUE FALIA, LOUISIANA.

* * * * * * *

During the past fiscal year no work has been done, the small balance of funds available being insufficient.

Snags and logs continue to accumulate, and bars form in the channel. These obstructions must be periodically removed, for which the sum of $3,000 will be required annually.

It is proposed to apply the available balance to the credit of this improvement to maintenance by dredging an 8-foot channel 60 feet wide through the bar at the mouth of the Chefuncte.

Money statement.

July 1, 1901, balance unexpended	$40.73
Amount appropriated by river and harbor act approved June 13, 1902 (allotted)	3,000.00
	3,040.73
June 30, 1902, amount expended during fiscal year	10.00
July 1, 1902, balance unexpended	3,030.73
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	3,000.00

ABSTRACT OF APPROPRIATIONS FOR IMPROVING CHEFUNCTE RIVER AND BOGUE FALIA, LOUISIANA.

By act of Congress—	
Approved March 3, 1881	$1,500
Passed August 2, 1882	1,500
Approved August 5, 1886	2,500
Approved September 19, 1890	1,000
Approved July 13, 1892 (maintenance)	1,000
Of August 18, 1894 (maintenance)	1,000
Passed June 3, 1896 (maintenance)	1,000
Approved March 3, 1899 (maintenance)	1,000
Approved June 13, 1902 (maintenance)	[a]3,000
Total	13,500

COMMERCIAL STATISTICS.

[From January 1, 1901, to December 31, 1901.]

Vessels entering and departing.

Class.	Number.	Trips.	Net registered tonnage.
Steamers	8	169	14,785
Sailing vessels	32	605	13,565
Barges	12	266	19,870
Total	52	1,040	48,220

Draft of heaviest vessel: Light, 5 feet; loaded, 7 feet.

Shipments and receipts, by water.

Articles.	Tons.	Value.
SHIPMENTS.		
Lumber	25,494	$165,710
Shells and sand	57,666	86,500
Cotton and cotton-seed products	555	88,480
Brick	2,290	9,732
Tar, rosin, and turpentine	1,841	24,612
Cord wood	548	1,918
Rice	100	2,486
Total	88,494	379,438
RECEIPTS.		
Merchandise	4,380	328,500
Grand total	92,874	707,938

T 3.

IMPROVEMENT OF TICKFAW RIVER AND ITS TRIBUTARIES, LOUISIANA.

* * * * * * *

No work has been done during the past fiscal year, sufficient funds not being available.

Snags and logs continue to accumulate in the channel, and the water hyacinth rapidly increases in quantity. It will be necessary to remove these obstructions from time to time. It is estimated that $1,000 annually will be required for the work.

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[a] Allotted.

It is proposed to expend the available funds in maintaining the improvements by removing obstructions from the Tickfaw from its mouth to the Natalbany River, from the Natalbany from the mouth to Ponchatoula River, and from the Ponchatoula as far as funds will permit.

Money statement.

July 1, 1901, balance unexpended	$20.19
Amount appropriated by river and harbor act approved June 13, 1902 (allotted)	1,000.00
	1,020.19
June 30, 1902, amount expended during fiscal year	10.00
July 1, 1902, balance unexpended	1,010.19
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	1,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

ABSTRACT OF APPROPRIATIONS FOR IMPROVING TICKFAW RIVER AND TRIBUTARIES, LOUISIANA.

By act of Congress—	
Approved March 3, 1881	$2,000
Passed August 2, 1882	2,000
Approved August 5, 1886	2,000
Of August 11, 1888	1,000
Approved September 19, 1890	1,000
Approved July 13, 1892 (maintenance)	1,000
Passed August 18, 1894 (maintenance)	1,000
Passed June 3, 1896 (maintenance)	1,000
Approved March 3, 1899 (maintenance)	1,000
Approved June 13, 1902 (maintenance)	[a]1,000
Total	13,000

COMMERCIAL STATISTICS.

[From January 1, 1901, to December 31, 1901.]

Vessels entering and departing.

Class.	Number.	Trips.	Net registered tonnage.
Steamers	7	163	3,904
Sailing vessels	14	207	3,110
Barges	2	58	3,320
Total	23	428	10,334

Draft of heaviest vessel: Light, 5 feet; loaded, 6.5 feet.

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[a] Allotted.

Shipments and receipts, by water.

Articles.	Tons.	Value.
SHIPMENTS.		
Lumber	26,892	$174,798
Logs	24,402	56,938
Cotton and cotton-seed products	48	7,640
Wood and staves	3,100	11,075
Miscellaneous	22	780
Total	54,464	251,231
RECEIPTS.		
Merchandise	2,000	150,000
Grand total	56,464	401,231

T 4.

IMPROVEMENT OF AMITE RIVER AND BAYOU MANCHAC, LOUISIANA.

* * * * * * *

During the fiscal year ending June 30, 1902, no work has been done toward this improvement, sufficient funds not being available.

Snags, logs, and trees continue to accumulate, and the banks cave. It is estimated that $2,500 annually will be required to maintain the existing improvement. It is proposed to apply the available balance to the credit of this improvement to maintenance by dredging an 8-foot channel 50 feet wide through the bar at the mouth of Amite River.

Money statement.

July 1, 1901, balance unexpended	$129.87
Amount appropriated by river and harbor act approved June 13, 1902 (allotted)	2,500.00
	2,629.87
June 30, 1902, amount expended during fiscal year	17.50
July 1, 1902, balance unexpended	2,612.37
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement in addition to the balance unexpended July 1, 1902	2,500.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

ABSTRACT OF APPROPRIATIONS FOR IMPROVING AMITE RIVER AND BAYOU MANCHAC, LOUISIANA.

By act of Congress—	
Approved June 14, 1880	$8,000
Approved March 3, 1881	5,000
Approved August 5, 1886	2,000
Of August 11, 1888	5,000
Approved September 19, 1890	3,800
Approved July 13, 1892 ($1,500 maintenance)	2,500
Of August 18, 1894 (maintenance)	2,500
Passed June 3, 1896 (maintenance)	2,500
Approved March 3, 1899 (maintenance)	2,500
Approved June 13, 1902 (maintenance)	[a] 2,500
Total	36,300

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[a] Allotted.

COMMERCIAL STATISTICS.

[From January 1, 1901, to December 31, 1901.]

Vessels entering and departing.

Class.	Number.	Trips.	Net registered tonnage.
Steamers	9	316	[illegible]
Sailing vessels	29	301	2,472
Barges	5	42	[illegible]
Total	43	659	[illegible]

Draft of heaviest vessel: Light 5.5 feet; loaded, 8 feet.

Shipments and receipts, by water.

Articles.	Tons.	Value.
SHIPMENTS.		
Lumber	16,278	$105,807
Logs	37,683	84,427
Staves, laths, and shingles	5,217	50,808
Cord wood	5,294	18,529
Cotton and cotton-seed products	1,711	150,717
Miscellaneous	135	8,619
Total	66,318	418,907
RECEIPTS.		
Merchandise	3,500	262,500
Grand total	69,818	681,407

T 5.

CLOSING CREVASSE IN PASS A LOUTRE, MISSISSIPPI RIVER.

* * * For details of the progress and completion of this work see page 1487, Annual Report of the Chief of Engineers for 1898, and page 1839 of Report for 1899.

* * * * * * *

During the fiscal year 210 feet of the dam has been washed away, increasing the break to 919 feet on June 30, 1902. Twenty-one feet of this was lost from the west end and 189 feet from the east end. The greatest loss occurred during a storm in August, 1901, when 206 feet of the dam was washed away.

That portion of the work from Y to D (see chart accompanying), $4,054\frac{5}{12}$ feet, is in good condition. From Y to range No. 2 the distance is 2,334½ feet, of which 1,235 feet is in good condition, 178 feet effective, but weak, 168 feet partially in place, but of no value, and 753½ feet completely lost. There has been practically no change in the depth of water during the year.

There were no operations during the year. The sum of $21,000 remains available from the appropriation, $1,000 being reserved March 6, 1902, for payment of certain expenses of the office of the Chief of Engineers.

Money statement.

July 1, 1901, balance unexpended	$22,004.92
March 16, 1902, amount withdrawn by office Chief of Engineers for expenses	1,000.00
July 1, 1902, balance unexpended	21,004.92

ABSTRACT OF APPROPRIATIONS FOR CLOSING CREVASSE IN PASS A LOUTRE, MISSISSIPPI RIVER.

By act of Congress approved February 26, 1897	[a]$250,000

T 6.

IMPROVEMENT OF THE OUTLET OF THE MISSISSIPPI RIVER.

* * * * * * *

Preparation of plans and specifications for the construction of the dredge, and advertisement of same, was first assigned to Maj. Thomas H. Handbury, Corps of Engineers. Bids received by him were in excess of the amount available. The plans have since been revised by Capt. J. C. Sanford, Corps of Engineers, and a contract has been made by him for construction of a dredge to cost $286,605. To June 30, 1902, the sum of $3,696.35 has been expended by this office in payment of expenses incurred by Major Handbury and Captain Sanford in connection with preparation of plans and letting of contract for this dredge. Captain Sanford was authorized by the Chief of Engineers to disburse $1,000 of the appropriation for the same purposes.

Money statements.

IMPROVEMENT OF OUTLETS TO MISSISSIPPI RIVER.

July 1, 1901, balance unexpended		$321,915.72
June 30, 1902, amount expended during fiscal year	$526.13	
October 30, 1901, amount allotted to Capt. J. C. Sanford by letter, office Chief of Engineers	1,000.00	
		1,526.13
July 1, 1902, balance unexpended		320,389.59

SOUTHWEST PASS, MISSISSIPPI RIVER.

Amount appropriated by river and harbor act approved June 13, 1902.	$750,000.00
July 1, 1902, balance unexpended and available	750.000.00
Amount (estimated) required for completion of existing project	5,250,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	2,250,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

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[a] Of this amount $10,000 was allotted by act of February 17, 1898, for survey of Southwest Pass, Mississippi River.

ABSTRACT OF APPROPRIATIONS FOR IMPROVING THE OUTLET OF THE MISSISSIPPI RIVER.

By act of Congress approved March 3, 1899	$200,000
By sundry civil act approved June 6, 1900	300,000
Total	500,000

ABSTRACT OF APPROPRIATIONS FOR IMPROVING THE SOUTHWEST PASS OF THE MISSISSIPPI RIVER.

By act of Congress approved June 13, 1902	$750,000

ABSTRACT OF CONTRACT IN FORCE DURING YEAR ENDING JUNE 30, 1902, FOR IMPROVING OUTLET OF THE MISSISSIPPI RIVER.

For construction of dredge boat.

Name and address of contractor: William R. Trigg Company, Richmond, Va.
Dated: 1901.
Approved: 1901.
Date of beginning: 1901.

Contract prices:

For hull and propelling machinery	$252,375
For pumps and machinery	32,050
For electric-light plant	2,180
Total	286,605

COMMERCIAL STATISTICS.

For commercial statistics for the port of New Orleans, see report on Maintenance of South Pass Channel, Mississippi River.

T 7.

MAINTENANCE OF SOUTH PASS CHANNEL, MISSISSIPPI RIVER.

This work was commenced on January 29, 1901, on the expiration of the contract for securing and maintaining a channel through South Pass entered into with the late James B. Eads, and was provided for by the emergency river and harbor act approved June 6, 1900, which directed the Secretary of War to take charge of the channel, jetties, and auxiliary works, and to maintain the channel with the utmost efficiency, and for that purpose authorized him to draw warrants on the Treasury for not exceeding $100,000 per year.

Under the provisions of the sundry civil act approved June 6, 1900, the dredge *Beta*, belonging to the Mississippi River Commission, was temporarily transferred for this work. Dredging was done in the pass above the jetties with this plant from February 4 to June 27, 1901. The plant was returned to the Mississippi River Commission in July, 1901, and the U. S. dredge *Sabine*, belonging to Sabine Pass improvement, was put on the work July 3, 1901.

The *Sabine* was operated five days in the channel between the jetties and nine days in channel beyond ends of the jetties up to July 25, when she became disabled by broken propeller wheel. No further dredging was done until in October, when the *Sabine* worked seven lays in jetty channel and five days beyond ends of jetties. The lredge was used in September to rescue pile driver, derrick boat, and arges which had been sunk or beached by a severe storm that occurred n August. This dredge was returned to Sabine Pass on October 26, .901.

In July, 1901, a tugboat, two wooden and one steel barges, tools, and ,000 tons of stone were purchased from the Eads estate. Two additional wooden barges were purchased in New Orleans in August. This plant and material, together with the other plant previously purchased from the Eads estate, were used for repairing the jetties, dikes, nd dams after necessary repairs had been made to the plant. Piles, waling timbers, and willows were purchased for the work.

The work of repairing the jetties and auxiliary works was commenced August 5, 1901, at the head of South Pass, in the Pass, and at he mouth of it, and continued throughout the balance of the fiscal ear. All were in effective condition when the river began to rise, so hat the scouring power of the current was fully utilized, and, on the whole, an excellent channel maintained.

On March 24, 1902, the Secretary of War approved a recommendation that the dredge *Beta* be put in readiness for use in South Pass. Request for the dredge was made on May 6. The dredge *Beta* arrived t Port Eads on May 20, and on the 26th began operations in Port Eads Reach, which was the shoalest locality in South Pass. After ighty-six hours' actual dredging 2,700 feet of channel was improved o that the depth varied from 31 to 33 feet, and the width of the 0-foot channel was not less than 40 feet. As a rule, however, the lepth was 33 feet, and the width of the 30-foot channel was 50 feet.

On June 14 the dredge was moved to Upper Base Reach and began lredging there on the 16th: she was employed in that locality at the lose of the fiscal year.

The shoalest localities in the entire 14 miles of channel from the nain river to the Gulf is in Goat Island and Upper Base reaches, where the available depth is 27.8 feet, and the aggregate length of hannel at four localities where the central depth is less than 30 feet s 6,140 feet, or 8.3 per cent of the entire channel.

The channel has been more successfully navigated during the past ear than during any previous year since it has been open. More leep-draft vessels and vessels of deeper draft passed through the hannel than ever before; the deepest draft was 27¼ feet.

The report, herewith, of Mr. C. Donovan, assistant engineer, is in letail and complete.

Money statement.

mount appropriated by river and harbor act approved June 6, 1900, for fiscal year 1902		$100,000.00
mount allotted from appropriation for "Emergencies in River and Harbor Works" (1902)		10,000.00
		110,000.00
une 30, 1902, amount expended during fiscal year	$100,074.38	
une 30, 1902, outstanding liabilities	9,447.69	
une 30, 1902, total cost of operations during fiscal year		109,522.07
une 30, 1902, balance reverting to Treasury		477.93

APPROPRIATION FOR ALTERING DREDGES.

July 1, 1901, balance unexpended	$5,901.09
November 20, 1901, deposit as repayment to appropriation	1.53
July 1, 1902, balance unexpended	5,902.62

ABSTRACT OF APPROPRIATIONS FOR SOUTH PASS CHANNEL, MISSISSIPPI RIVER.

Maintenance.

By act of Congress—

Approved June 6, 1900 (indefinite), annually	$100,000
Approved June 6, 1900 (allotted)	10,000
Approved June 13, 1902	75,000

Examinations and surveys.

By act of Congress approved June 13, 1902 (indefinite), annually	$10,000

COMMERCIAL STATISTICS.

[From January 1, 1901, to December 31, 1901.]

Port of New Orleans, La.

[From information furnished by collector of port of New Orleans.]

Class.	Entered.		Cleared.	
	Number.	Tonnage.	Number.	Tonnage.
FOREIGN-BOUND VESSELS.				
Steamers	1,207	1,949,598	1,246	2,086,985
Sailing vessels	29	22,433	44	33,936
COASTWISE VESSELS.				
Steamers	344	859,876	284	698,435
Sailing vessels	35	15,247	45	17,112
Total	1,615	2,847,154	1,619	2,836,468

Foreign exports and imports.

Articles.	Year ending Dec. 31, 1901.	
	Tons.	Value.
EXPORTS.		
Cotton and cotton-seed products	800,757	$93,939,329
Grain	1,131,793	24,716,320
Flour	67,446	2,663,144
Lumber, boards, staves, etc	434,510	5,897,868
Stock (live)	61,266	7,580,155
Pig iron	18,008	228,497
Zinc ore	14,563	402,082
Leaf tobacco	10,889	2,085,194
Lard	4,383	761,050
Miscellaneous	184,964	5,549,528
Total exports	2,728,594	143,818,112
IMPORTS.		
Coffee	51,089	6,715,966
Cement	12,023	69,302
Salt	9,918	56,398
Sugar	129,825	5,634,689
Fruits and nuts	158,414	2,458,968

Foreign exports and imports—Continued.

Articles.	Year ending Dec. 31, 1901.	
	Tons.	Value.
IMPORTS—continued.		
Sisal grass (unmanufactured)	21,139	$2,179,869
Jute fabrics	38,257	3,740,663
Cotton fabrics	9,817	248,618
Chemicals, drugs, dyes, etc	3,284	146,103
Wines, brandy, and malt liquors	893	348,355
Tin and tin plate	3,946	216,141
Cotton ties	3,200	102,829
Iron and steel manufactures	2,029	105,777
Tobacco (leaf, cigars, etc.)	116	199,835
Mattings (floor)	2,098	214,174
Fertilizers, etc	2,813	56,260
Earthen, china, and glass ware	1,939	193,998
Miscellaneous	12,465	1,216,693
Total imports	458,260	23,899,138
Total exports and imports	3,186,854	167,717,250

Domestic shipments and receipts by Cromwell and Morgan steamship lines.

Articles.	Year ending Dec. 31, 1901.	
	Tons.	Value.
SHIPMENTS.		
Sugar	111,769	$8,941,498
Molasses	57,633	4,037,185
Cotton	105,537	16,878,600
Rice	21,410	1,712,757
Lumber	19,117	467,500
Grain	39,811	1,029,595
Ores, bullion, etc	108,080	5,728,240
Agricultural products	41,677	901,821
Miscellaneous	79,826	239,783
Total shipments	584,860	39,936,979
RECEIPTS.		
Sugar	39,415	3,154,000
Machinery	68,425	5,131,875
Iron, steel, and metals	2,088	104,400
Groceries and provisions	64,131	14,108,820
Merchandise	107,998	21,599,600
Manufactured products	84,967	976,952
Miscellaneous	75,131	2,795,862
Total receipts	442,155	47,871,509
Grand total	1,027,015	87,808,488

REPORT OF MR. C. DONOVAN, ASSISTANT ENGINEER.

United States Engineer Office,
Port Eads, La., July 1, 1902.

Sir: I have the honor to report upon the maintenance of South Pass channel, Mississippi River, during the fiscal year ending June 30, 1902, as provided for in an act of Congress approved June 6, 1900.

As soon after July 1, 1901, as practicable, necessary plant was purchased and put in serviceable condition, materials contracted for, etc., and on August 5 active operations were begun to maintain the jetties and auxiliary works in connection with which no work had been done during the preceding six months.

On August 13, 14, and 15, 1901, this locality was visited by the most violent storm ever known here, and although no great damage was caused to the jetties and auxiliary works, still their subsidence was augmented to a degree fully equal to one year's normal deterioration. Every dike, dam, etc., except the inner east jetty, settled so that they were beneath the surface of the water, and the latter was below the surface at some localities. A large pile driver was sunk and considerably damaged, the derrick boat sunk at her wharf and was slightly damaged, and a large barge, used for transporting willows, was driven ashore, without damage, 2 miles above the Head of the Passes.

All buildings and their contents were more or less injured by wind, flood, or rain, and three dwelling places were rendered uninhabitable. Walks were washed away, trees uprooted, and débris and heavy drift deposited on the storage ground on the east bank of the pass. With few exceptions, sounding ranges and instrument stations were destroyed.

After making ways about here passable, removing mud from dwellings, office, shops, etc., active operations were again renewed on August 19.

To put all works in the most effective condition possible under the circumstances before the river began to rise, so that the force of the current would be fully utilized, was the primary object to be attained. As contractors for piling, timber, etc., were derelict, and as the piling in some of the structures were in condition to hold willows, the work of filling them was vigorously prosecuted, and when other materials arrived other structures were repaired or rebuilt and all were in effective condition when the river began to rise. The results produced by way of channel improvement were highly satisfactory and gratifying.

While preparations were being made to begin operations a party representing an association came to me and said they were about to complain of seeming lack of attention to necessary work in connection with the jetties and auxiliary works. I assured him that such action would be unnecessary and of no avail, since the work was then in hand and would soon be progressing rapidly. I make this statement in order to convey more clearly the impression of others as to the condition of the work about the time it was taken in hand.

MAINTENANCE OF JETTIES, DIKES, DAMS, ETC.

AT THE HEAD OF SOUTH PASS.

West dike.—This structure, also known as West T-head, was put in effective condition by the renewal of some of the piling and other timber and the addition of willows weighted with stone and earth. It is 885 feet long.

On the morning of March 31, 1902, a portion of this dike gave way in consequence of the falling of a structure known as West Light, which was built partially on the dike and partially on piles independent of the dike. The piles were undermined by a strong eddy, and as the foundation timbers of the structure were firmly bolted to timbers in and a part of the dike, the result of its falling was to tear out a section of the dike 79 feet in length, beginning 56 feet from the upper end. The work of restoring this section was immediately begun, but before it was completed the section 56 feet in length from the upper end had washed out, and the renewal of the whole necessitated the building of a section 170 feet long and 16 feet wide. It was with great difficulty, owing to the very strong current, that the work was successfully accomplished.

The work is now in good condition, but will be made stronger and more permanent during the coming year.

This dike and other works which will be referred to in this locality are shown on Chart No. 4, and further on will be found a statement of materials and labor expended in connection with each.

Upper dam.—This dam is 416 feet long, and was maintained in good condition by the addition of piling, willows, stone, and earth. A threatened undermining of the west end during the month of April was arrested, and that end made more secure.

Cut-off dike.—This dike connects with upper dam on the lower side of the same, and originally closed a channel between upper dam and the mainland below it. On April 22 a section 100 feet in length of this dike, beginning 115 feet below upper dam, was undermined and lost. Repairs were completed May 10, and that night some craft, as yet unknown, ran into the work and damaged it to such an extent that it cost $100 to repair it. Repairs were made at once, and the work is now in good condition.

IN SOUTH PASS.

Grand Bayou and Goat Island reaches.—These localities are, respectively, about 5 and 9 miles above South Pass light-house. In the former there are 7 wing dams and in the latter there are 5, as represented on charts 2 and 3. All were made effective by the addition of willows and earth, and from time to time in the future they will be made more permanent by the renewal of the piling and other timber.

AT THE MOUTH OF SOUTH PASS.

All works at this locality are represented on Chart No. 1.

East jetty.—No work has been done on this jetty since 1893, and it is probable that one will ever be required, since the inner jetty may be made sufficiently efficient. The land formation about and to the eastward of this jetty has been receding for veral years, but during the past year there was practically no recession.

The condition of this jetty is as follows: For 2,150 feet from East Point, its origin, is beneath the surface of the land which has formed about and over it. For the ext 4,055 feet it is as originally built of mattresses and stone; the upper surface is ow about 4 feet below the plane of average flood tide. The remainder of the jetty capped by a concrete wall, which is in fair condition and protects the inner east tty from the force of heavy seas.

For a distance of 2,000 feet from the upper end the elevation of the wall averages 4 of a foot above average flood tide, and the remainder of it is below that plane, e whole averaging 0.4 of a foot below.

West jetty.—As represented on the chart, this jetty is entirely buried by the land hich has formed since it was built. It is not probable that any further work will er be required in connection with it.

Inner east jetty.—The subject of the principal work at the mouth of the pass is the ,730 feet of this jetty from the sea end. From that point for a distance of 5,640 et the work was put in good condition by the addition of willows and stone; that , in such condition that, under ordinary circumstances, further work will not be equired on this portion for nearly two years. Five hundred feet of this jetty was artially completed, and in places where most required the piling was renewed.

Inner west jetty.—No work was done on this jetty during the year, as there was othing that required urgent or immediate attention. Early in the coming year the rib work at the outer end will be built up, and that is about all that is required.

Wing dams.—Each of the 37 wing dams shown on Chart No. 1 were more or less epaired, and some were rebuilt. They are as a rule in good condition, and all are n serviceable or effective condition.

The following is a statement of materials expended in the maintenance of jetties nd auxiliary works, and where used:

	Willows.	Stone.	Piles.			
			30 feet long.	40 feet long.	50 feet long.	60 feet long.
	Cords.	*Cu. yds.*				
ner east jetty	8,696.9	2,516.1	......	21	6	......
tty wing dams	2,089.2	124.6	18	97	64	1
ng dams.						
Grand Bayou Reach	522.8	31	......	......	2	10
Goat Island Reach	243.4	......	......	......	......	......
est dike, head of South Pass	2,528.3	228	......	......	3	176
pper dam, head of South Pass	773.2	56	......	......	......	23
t-off dike, head of South Pass	531.5	38	......	......	......	35
nding for pile driver	......	......	8	......	......	......
al-yard wharf	......	......	5	......	......	......
oorings	......	......	33	......	......	1
Total	15,385.3	2,993.7	64	118	75	246

	Timber 12 by 12 inches.	Screw bolts.			Planks 2¼ by 12 inches.
		24 inches long.	27 inches long.	29 inches long.	
	Lin. feet.				
ner east jetty	300	......	64	......	......
tty wing dams	2,019	8	237	130	......
ing dams, Grand Bayou Reach	160	......	24	5	......
est dike, head of South Pass	1,618	......	238	59	......
pper dam, head of South Pass	420	......	50	8	......
ut-off dike, head of South Pass	155	......	33	......	......
anding for pile driver	120	......	8	......	140
oal-yard wharf	180	......	15	......	220
Total	4,972	8	669	202	360

The number of hours of labor during the year was 29,177½, and it was distributed as follows:

Labor on—	Placing willows.	Loading stone on barges, and placing same.	Removing and replacing stone.	Driving piles, etc.	Loading earth on barges, and placing same.	Miscellaneous work.	Clearing driftwood from works.
Inner east jetty	7,028¼	4,816½	4,360½	158			857
Jetty wing dams	1,641¼	21	61½	1,096			
Wing dams:							
Grand Bayou Reach	380	18		100	154		
Goat Island Reach	197				120		
West dike, head of South Pass	1,906	121½		1,059	1,768½		
Upper dam, head of South Pass	586	54		196½			35
Cut-off dike, head of South Pass	406	21		216			
Moorings				87½			
Sharpening piles						356½	
Piling timber, lumber, and piles						203	
Removing débris, repairing walks, etc., at Port Eads						182½	
Carpenter's helper on repairs to floating plant						308	
Putting wire cables on west dike						70	
Painting floating plant						207½	
Loading piles for Fort St. Philip						49	
Securing spare pile hammer, and adjusting same						42½	
Pile-driver landing				44			
Pulling piles, head of South Pass						33	
Coal-yard landing				32½			
Rigging pile driver						31	
Rigging derrick boom						17	
Engineer's helper, launch Ubsdell						49	
Twelve miscellaneous items						86	
Total	12,144½	5,052	4,422	2,989½	2,042½	1,655	892

DREDGING.

Dredge Sabine.—The dredge *Sabine* arrived here July 2, 1901, and began dredging on July 5. On July 18 her starboard pump shaft was broken, and on July 24 a fluke was broken off her port wheel. July 25 to September 19, disabled and undergoing repairs.

She arrived back here September 19, and from September 20 to October 3, inclusive, she was engaged in raising the pile driver and derrick boat which were sunk during the August storm and in launching a barge which was driven ashore at the same time.

From October 5 to 22 she was engaged in dredging. On October 23 she towed the pile driver to the city for repairs. Returning here on October 26, she left on the same date for Sabine Pass, Tex.

During the time from July 2 to October 26 her pumps were operated 140½ hours in the jetty channel and the channel beyond the ends of the jetties. The channel was somewhat improved, but not sufficient work was done to test the boat's efficiency in removing the stiff clay which is found here.

Dredge Beta.—The dredge *Beta* arrived at Port Eads on May 20, and from that time to the 26th the work of coupling the pipe line and arranging other necessary details was done.

Port Eads Reach.—This reach embraces about 2,700 feet of channel above East Point, and on May 21 its available depth was 26.4 feet, the 26-foot channel being 215 feet wide.

The dredge began work in this reach on May 26, and from that time until June 13, inclusive, 86 hours' actual dredging was done and the channel depth increased to 31.1 feet, the 26-foot channel being 225 feet wide and the 30-foot channel 40 feet wide. Generally, however, the depth was 33 feet and the average width of the 30-foot channel was 50 feet.

The dredge was operated in this reach 165 hours, and the distribution of that time was as follows: 52 per cent dredging, 8 per cent moving for steamers to pass, 40 per cent arranging plant, repairs, etc.

Upper Base Reach.—The center of this reach is about 1½ miles above South Pass light-house, and on June 12 there was about 4,000 feet of channel having a depth less than 30 feet, the available depth being 27.5 feet, and the 26-foot channel was

270 feet wide. Dredging was commenced June 16, and from that time to June 28, inclusive, 47 hours' actual dredging was done, and 2,300 feet of channel increased to a depth varying from 31½ to 33 feet, the width of the 30-foot channel being 50 feet.

The distribution of time thus far in this reach was as follows: 54½ per cent dredging, 14 per cent moving for steamers to pass, and 31½ per cent arranging plant, repairs, etc.

The dredge is still working in this reach.

THE PLANT.

The floating plant, which alone is owned by the United States, consists of 1 tug, 2 steam launches, 1 pile driver, 1 derrick boat, 8 barges, 1 yawl boat, and 4 skiffs.

The pile driver required extensive repairs on account of the damage caused by the August storm. The tug and launches were docked, and every article of plant painted and more or less repaired. All are in good condition, and are of more value than when I took charge of them.

THE FORCE EMPLOYED.

The permanent force consists of 1 assistant engineer in local charge, 2 junior engineers, 1 overseer, 1 master, 3 steam engineers, 1 carpenter, 1 stoker, 1 leadsman, 4 deck hands, 1 gauge observer, and one watchman, being 17 in number. The laboring force averaged 13 men.

EXAMINATIONS AND SURVEYS.

Weekly surveys were made of the shoaler localities in South Pass and the jetty channel, monthly surveys of the jetty channel and of the channel beyond the ends of the jetties to deeper water in the Gulf, and a detailed annual survey embracing the entire 14 miles of channel from the main river to the Gulf, the charts of which accompany this report.

These surveys, together with the charting of them, the reduction of tidal and wind records, etc., keep the survey party well employed.

Head of the Passes.—The chart of this survey is No. 4, and shows the entrances to the three passes from the main river. The shoalest water during the year was confined to one section, which is 1,000 feet north and 500 feet east from Head of Passes lighthouse, where the depth was 27 feet. This did not prove any impediment to navigation, and with the rising river the depth increased rapidly.

On June 9 the depth of the channel entrance to South Pass was 34.4 feet, and the 30-foot channel was nowhere less than 200 feet in width.

In South Pass.—From July 1, 1901, to May 8, 1902, the channel throughout South Pass was not less than 27 feet in depth. On May 8 the depth in Port Eads Reach was 26.3 feet, which was the shoalest obtained during the year.

The depth in Grand Bayou and Goat Island reaches was not at any time less than 28 feet, and in Upper Base Reach it was not less than 27.2 feet.

The jetty channel.—The depth of this channel varied within narrow limits during the year, the minimum depth at any time being 28.3 feet, which obtained but for a short time, and the 26-foot channel, near the end of the jetties, was for a short time but 156 feet wide.

With the rising river the channel improved rapidly, and, with the exception of the depth on one cross section, which is 29.7 feet, the channel is not less than 30 feet in depth and the 26-foot channel is not less than 200 feet in width.

The channel beyond the ends of the jetties.—A depth of 30 feet or more was maintained in this channel except for a few days during the month of August, 1901, when the depth was 29.5 feet, and up to the month of June, when the effect of the falling river caused a shoaling which reduced the depth to 29.2 feet. The distance across this shoaler area from 30-foot depth inside to the same depth outside is 40 feet.

As a rule, this channel deepens during the low-river period because of the action of the salt-water currents.

The present channel.—At the present time, June 28, the shoalest depth in the entire 14 miles of channel from the main river to the Gulf is in Goat Island and Upper Base reaches, where the available depth is 27.8 feet, and the aggregate length of channel not having a central depth of 30 feet is 6,140 feet, or 1.14 miles.

THE NAVIGATION OF THE CHANNEL.

The channel has been more successfully navigated during the past year than during any year since it has been open, in that a greater number of steamers of greater draft than ever before have passed through the channel, and not the slightest mishap was noted.

From July 1, 1901, to June 1, 1902, 16 steamers drawing 26 feet or more passed out, as follows: Five of 26 feet, 3 of 26⅛ feet, 1 of 26¼ feet, 1 of 26½ feet, 1 of 26¾ feet, 4 of 27 feet, and 1 of 27⅛ feet.

Six of the 16 deep-draft steamers belong to the Leyland Line, and their draft was as follows: One of 26⅛ feet, 1 of 26¾ feet, 3 of 27 feet, and 1 of 27⅛ feet, the deepest during the year.

With one exception the deepest draft steamers belong to one line, and if, as Mr. M. J. Sanders says, "the reduced draft will mean considerably reduced earnings on all large vessels," the question suggests itself as to why a greater number of steamers, and those of other lines, have not benefited by the facilities which South Pass has offered.

The following extract from a letter from the president of the Associated Branch Pilots explains itself: "In reply to your inquiry as to the successful navigation through South Pass during the past year, I beg to state that the pilots found the channel deeper and wider; that our records show that a larger number of deeper steamers have gone through the pass with less trouble than ever before."

It is estimated that $60,000 may be expended during the coming year in maintaining the jetties, auxiliary works, plant, etc. The expense of dredging can not well be estimated, since the amount of dredging required depends so largely upon the stage of the river. Comparatively little was required during the past year, but much more, or perhaps none at all, may be required during the coming year.

Very respectfully,

C. Donovan, *Assistant Engineer.*

Lieut. Col. H. M. Adams,
Corps of Engineers.

T 8.

IMPROVEMENT OF BAYOU LAFOURCHE, LOUISIANA.

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During the past fiscal year dredging has been done for the maintenance of low-water navigation, under contract with John J. Keegan, dated June 3, 1901. Work was commenced on June 25, 1901, and continued until December 31, 1901, when the stage of water was such as to render dredging unnecessary. The dredge, with a double crew, was furnished for $65 per day of 16 hours. The operations of the dredge extended over a distance of 8¼ miles, and actual dredging was done over 4.6 miles of this stretch. Six bars and 15 snags were removed and wrecks of 7 flatboats were broken up. The amount of material dredged was 66,919 cubic yards. The dredge was employed 150 5/32 days.

The project approved July 3, 1902, for the expenditure of $7,500 appropriated by river and harbor act of June 13, 1902, provides for dredging operations in the bayou to maintain flatboat navigation.

The sum of $7,500 will be required annually for maintenance of this improvement.

Money statement.

July 1, 1901, balance unexpended	$12,200.89
Amount appropriated by river and harbor act approved June 13, 1902	7,500.00
	19,700.89
June 30, 1902, amount expended during fiscal year	11,227.46
July 1, 1902, balance unexpended	8,473.43

ABSTRACT OF APPROPRIATIONS FOR IMPROVING BAYOU LAFOURCHE, LOUISIANA.

By act of Congress—

Approved June 13, 1878	$10,000
Approved March 3, 1879	10,000
Approved June 14, 1880	5,000
Approved July 5, 1884	5,000
Of August 11, 1888	50,000
Approved September 19, 1890	50,000
Approved July 13, 1892	50,000
Of August 18, 1894	40,000
Passed June 3, 1896	25,000
Approved March 3, 1899 (maintenance)	7,500
Approved June 13, 1902 (maintenance)	7,500
Total	260,000

ABSTRACT OF CONTRACTS IN FORCE DURING YEAR ENDING JUNE 30, 1902, FOR IMPROVING BAYOU LAFOURCHE, LOUISIANA.

For dredging and removing obstructions.

Name and address of contractor: John J. Keegan, New Orleans, La.
Work: Furnishing dredge boat and crew at $65 per day of sixteen hours.
Dated: May 20, 1901.
Approved: June 3, 1901.
Date of beginning: June 25, 1901.
Date of completion: December 31, 1901.

COMMERCIAL STATISTICS.

[From January 1, 1901, to December 31, 1901.]

Vessels entering and departing.

Class.	Number.	Trips.	Net registered tonnage.
Steamers	18	386	67,320
Sailing vessels	14	160	1,600
Barges and flatboats	48	1,024	71,680
Total	80	1,570	140,600

Draft of heaviest vessel: Light, 3 feet; loaded, 9 feet.

Shipments and receipts, by water.

Articles.	Tons.	Value.
SHIPMENTS.		
Sugar	30,097	$2,257,275
Molasses	12,469	374,070
Rice	2,037	83,517
Moss	832	33,280
Potatoes	839	25,170
Total	46,274	2,773,312
RECEIPTS.		
Merchandise	56,283	4,221,225
Fertilizer and feed stuff	3,000	45,000
Machinery	1,000	100,000
Cooperage	800	40,000
Coal	30,000	135,000
Total	91,083	4,541,225
Grand total	137,357	7,314,537

T 9.

IMPROVEMENT OF BAYOU PLAQUEMINE, GRAND RIVER, AND PIGEON BAYOUS, LOUISIANA.

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For a detailed record of the improvements see Annual Report of the Chief of Engineers for 1896, pages 1496–1500; for 1897, pages 1759–1760; for 1898, pages 1471–1472; for 1900, pages 2251–2258; for 1901, pages 1890–1898.

The river and harbor act of June 3, 1896, authorized continuing contracts to be entered into to complete the project, not to exceed $1,173,250, exclusive of amounts therein and previously appropriated. This entire amount, with the exception of $13,250, has since been appropriated by Congress.

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For convenience of reference the operations for the past fiscal year are given under subheadings.

PLAQUEMINE LOCK.

The foundation for this lock was completed December 31, 1897, under contract with E. A. Burriss, dated June 24, 1895.

A contract, amounting approximately to $501,757.60, for constructing the lock and excavating approaches, was entered into with Stewart & Co., on May 28, 1898, to be completed by June 30, 1903. Preliminary work was commenced in August, 1898, and construction work on February 2, 1899.

At the end of the last fiscal year the following work on the lock had been completed: All of the masonry, with the exception of recesses left in the lock walls for the operating machinery; 5 miter sills; the top anchorages for the main gates; 3 rows of snubbing hooks; 20 inlet pipes placed.

Work on the lock has been at a standstill since November 15, 1900, although there still remains, to complete the contract, the excavation between the lock and the railroad bridge, the fill behind the lock walls, the erection of the gates, the building of connecting levees, and the excavation of the river approach; estimated cost, $194,653.10.

A Board of Engineer officers was constituted by Special Orders No. 10, Headquarters, Corps of Engineers, 1902, to consider certain questions relative to this contract. The Board submitted a report May 22, 1902, recommending that work be resumed on original plans and completed without delay, subject to conditions as regards gates and excavation.

They recommended that the gates be constructed according to the original plans and under the original contract, and the sheathing plates on the upstream side to be put on under a new or supplemental contract.

They also recommended the construction of four embankments back of the four wing walls subject to the ordinary requirements used in levee construction by a new or supplemental contract, and the filling of the space or pit between these embankments with the material as found in the excavation, without being placed in layers or tamped or cleaning of the pit.

Stewart & Co. have been asked to submit a price for the extra items recommended by the Board.

On August 9, 1900, a crack in the floor of the lock began to develop, owing to settlement of the walls. Frequent levels have been taken since that date, and it is thought that the settlement has now very materially diminished.

For testing purposes 100 tons of pig iron were placed on one pivot stone of the gates in July and a second 100 tons on another pivot stone in November, 1901, and removed in May, 1902.

No work has been done under contract entered into November 18, 1899, with the Otis Elevator Company for constructing and installing operating machinery and power house, at a cost of $114,000. The commencement of this work is contingent upon completion of the lock.

Plans for the construction of the river approach to the lock, at an estimated cost of $114,000, were prepared and approved April 20, 1901. The execution of this work will be deferred until the lock is nearer completion.

The purchase of 1.25 acres of land on the north side of the river approach to the lock for $3,500 and 0.31 acre on the south side of the river approach for $4,000 was completed August 24, 1900. This land was required for the approach to the lock.

A contract with John Short for construction of a protection levee was entered into April 23 and approved May 5, the work to be completed by August 7, 1902. About one-third of the work was completed on June 30, 1902.

RECTIFICATION OF BAYOU PLAQUEMINE.

During the year dredging has been done under contract with Charles Clarke & Co., entered into July 15, 1899. The time for completion of this contract, originally fixed at June 30, 1901, was extended June 1, 1901, until June 30, 1902, and has since been waived for a reasonable period by authority of the Chief of Engineers. The contractors have been notified to proceed with the work as rapidly as possible. The contract provides for the removal of about 1,027,509 cubic yards of material for the purpose of forming a channel 125 feet wide and 10 feet deep over a length of 5.08 miles. To the close of the previous fiscal year 364,230 cubic yards had been removed. During the past year 38,400 cubic yards have been removed.

GRAND RIVER AND PIGEON BAYOUS.

These streams form part of the Plaquemine all-water route, connecting a number of navigable streams of Louisiana with the Mississippi River, and their improvement was added to the general project by act of July 13, 1892.

Dredging and snagging operations were carried on in these streams from 1893 to 1897, but obstructions continued to form.

Dredging and snagging operations were carried on in Grand River, from June 30, 1900, to April 20, 1901, from a point 3½ miles above

Bayou Pigeon, in that stream, and on down toward Bayou Posteo. A bar at the mouth of Bay Natchez was also removed.

A survey of Grand River from Pigeon Bayou to Atchafalaya River near Morgan City, through Bay Natchez, Bayou Long, and Flat Lake, was completed March 25, 1901. A project was approved April 20, 1901, and modified March 21, 1902, for dredging a channel 50 feet wide, 10 feet deep, in Flat Lake and Bay Natchez. A contract for the work was entered into April 3, and approved May 1, 1902. The contractors are now preparing to commence work.

BANK PROTECTION.

During the past year there has been no additional caving of the banks of the Mississippi River in the vicinity of the Plaquemine lock.

Under the project approved July 14, 1900, for expenditure of funds appropriated by the sundry civil act of June 6, 1900, work of bank protection is to be done. A contract for the work was entered into with John Short on March 9, 1901. Work was commenced October 5, 1901, and completed April 7, 1902.

This and other work done during the fiscal year are fully described in the accompanying report of Mr. J. I. Conklin, superintendent, at Plaquemine, La., to which attention is invited.

It is proposed to expend the vailable balance to the credit of this appropriation in completing the lock and approaches, building protection levee, dredging in Bayou Plaquemine, and in Flat Lake and Bay Natchez, Louisiana.

Money statement.

July 1, 1901, balance unexpended	$783,277.70
June 30, 1902, amount expended during fiscal year, including $1,000 withdrawn for expenses in office Chief of Engineers, June 20, 1901	88,269.73
July 1, 1902, balance unexpended	695,007.97
July 1, 1902, outstanding liabilities	25,894.39
July 1, 1902, balance available	669,113.58
July 1, 1902, amount covered by uncompleted contracts	476,271.19

ABSTRACT OF APPROPRIATIONS FOR IMPROVING BAYOU PLAQUEMINE, LOUISIANA.

By act of Congress—	
Of August 11, 1888	$100,000
Approved September 19, 1890	100,000
Approved July 13, 1892	150,000
Of August 18, 1894	110,000
Of June 3, 1896	20,000
By sundry civil act approved—	
June 4, 1897	350,000
March 3, 1899	400,000
June 6, 1900	200,000
March 3, 1901	210,000
Total	1,640,000

ABSTRACT OF CONTRACTS IN FORCE DURING THE YEAR ENDING JUNE 30, 1902, FOR IMPROVING BAYOU PLAQUEMINE, GRAND RIVER, AND PIGEON BAYOUS, LOUISIANA.

For constructing lock and approaches.

Name and address of contractor.	Dated.	Approved.	Date of beginning.	Date of expiration.
Stewart & Co., St. Louis, Mo	May 28, 1898	June 17, 1898	Aug. 16, 1898	June 30, 1903.

Items.		Approximate quantity.	Price.	Amount.
Concrete	cubic yards	84,713	$3.37	$285,482.81
Granite	cubic feet	6,304	2.00	12,608.00
Medium steel	pounds	1,788,019	.03 9/10	69,732.74
High steel, forged	do	16,600	.09 1/5	1,527.20
High steel, cast	do	206,372	.07 1/2	15,477.90
Cast iron	do	125,342	.03	3,760.26
Bronze	do	275	.32	88.00
Iron pipe, 1¼-inch	linear feet	1,565	.50	782.50
Timber	feet B. M.	1,273	30.00	38.19
Sluice valves	each	16	78.75	1,260.00
Excavation	cubic yards	300,000	.37	111,000.00
Total				501,757.60
Amount performed to June 30, 1902				306,975.85
Amount remaining to be done July 1, 1902				194,781.75

For constructing operating machinery and power house for lock.

Name and address of contractor.	Dated.	Approved.	Date of beginning.	Date of expiration.
Otis Elevator Co., New York, N. Y.	Nov. 18, 1899	Dec. 30, 1899	When notice shall be given to the contractor.	Six months after notice to commence has been given.

The entire work to be completed for an amount of $114,000.
Notice to commence had not been given and no work had been done up to June 30, 1902.

For dredging to enlarge the bed of Bayou Plaquemine from the railroad bridge to deep water below Dardennes Bend.

Name and address of contractor.	Dated.	Approved.	Date of beginning.	Date of expiration.
Chas. Clarke & Co., Galveston, Tex.	July 15, 1899	Sept. 13, 1899	Nov. 12, 1899	June 30, 1901; extended to June 30, 1902.

About 1,027,609 cubic yards of material to be removed; contract price, 13.98 cents per cubic yard total amount about $143,645.76.

A total of 402,630 cubic yards of material had been removed up to June 30, 1902.

For bank protection at the head of Bayou Plaquemine.

Name and address of contractor.	Dated.	Approved.	Date of beginning.	Date of expiration.
John Short, St. Charles, Mo.	Mar. 9, 1901	Mar. 23, 1901	When low water of 1901 reaches such stage as to permit operations.	Dec. 31, 1901

For 46,667 square yards brush mattresses, at 57 cents, amounting to $26,600.19; and 10,153 tons riprap stone, at $2.58, amounting to $26,194.74; total, $52,794.93.

Completed April 7, 1902.

For construction of protection levee at Plaquemine lock.

Name and address of contractor.	Dated.	Approved.	To be completed.	Work.
John Short, St. Charles, Mo..	Apr. 23, 1902	May 5, 1902	Aug. 7, 1902	Placing about 18,000 cubic yards earth in constructing levee and filling behind lock wall, at 27 cents per cubic yard.

For dredging Flat Lake and Bay Natchez, Grand River, Louisiana.

Name and address of contractor.	Dated.	Approved.	Date of beginning.	Date of expiration.
Chas. Clarke & Co., Galveston, Tex	Apr. 3, 1902	May 1, 1902	July 5, 1902	July 5, 1903

For removing not exceeding 377,000 cubic yards of material; contract price, 20 cents per cubic yard.

COMMERCIAL STATISTICS.

[From January 1, 1901, to December 31, 1901.]

Vessels entering and departing.

Number		135
Net registered tonnage		2,669
Draft of heaviest vessel:		
Light	feet..	8
Loaded	do ..	9

Shipments and receipts, by water.

Articles.	Tons.	Value.
SHIPMENTS.		
Merchandise	68,000	$1,576,400
Sugar cane	35,000	122,000
Total	103,000	1,698,400
RECEIPTS.		
Fish, oysters, fur, and produce	10,000	427,600
Coal	50,000	175,000
Logs	120,000	1,782,000
Total	180,000	2,384,600
Grand total	283,000	4,083,000

NOTE.—At present no vessels are engaged in regular trade on Bayou Plaquemine. The principal part of the freight is handled in small flats. There is no way of determining the tonnage of or number of trips made by each.

REPORT OF MR J. I. CONKLIN, SUPERINTENDENT.

PLAQUEMINE, LA., *June 30, 1902.*

SIR: I have the honor to submit the following report of the work under appropriations for improving Bayou Plaquemine and Grand River, Louisiana, in charge of this office, for the fiscal year ending June 30, 1902.

CONTRACTS IN FORCE JUNE 30, 1902.

Stewart & Co.—Building lock and excavating approaches.

Charles Clarke & Co.—Widening and deepening Bayou Plaquemine between railroad bridge at Plaquemine and Dardennes Bend, a distance of 5.08 miles.

Charles Clarke & Co.—Excavating a 50-foot channel, 10-foot depth, with perpendicular sides, in Flat Lake and Bay Natchez, Louisiana, respectively, 1.9 and 7 miles in length.

John Short.—Building a protection levee from the northeast corner of Plaquemine Lock to the present levee in front of the lock.

Plaquemine Lock.—Up to June 30, 1901, there had been accomplished by Stewart & Co. the following work:

Excavation	cubic yards	29,833
Concrete	do	80,832
Granite	cubic feet	6,072
Cast iron	pounds	129,198
Medium steel	do	5,900
High steel:		
Cast	do	32,256
Forged	do	15,955
Bronze	do	624

There has been no actual construction under this contract during the year, and the condition of the work is the same as at the end of the last fiscal year, with the exception of the removal of portions of the contractor's plant. There still remains, to complete the contract made with Stewart & Co., the excavation between the lock and the railroad bridge, the fill behind the lock walls, the erection of the gates, and the excavation of the approach.

Settlement of the lock walls.—The settlement of the lock walls has been very slight during the past year, as will be shown by the following table:

[Settlement in feet.]

	A.	B.	C.	D.	E.
Sill 1	0.018	0.019	0.010	0.003	0.018
Sill 2	.025	.007	.006	.012	.031
Sill 3	.030	.014	.001	.013	.035
Sill 4	.027	.010	.003	.030	.036
Sill 5	.029	.009	.002	.021	.027

A and E are points on each sill next to lock walls, C is center of each sill and is on longitudinal axes of lock, and B and D are intermediate points on sill. The settlement represents differences in elevations of sill taken on June 15, 1901, and June 20, 1902. At A, sill 4, there was 100 tons of pig iron from November 14, 1901, to May 24, 1902. At E, sill 4, there was 100 tons of pig iron from July 23, 1901 to May 30, 1902.

It is to be noted that at the points where the extra weights of 100 tons were applied there was no greater settlement than on sills where there were no extra weights applied.

Bank protection.—A contract was entered into with John Short, on March 9, 1901, for the making and placing of willow mattresses about one-half mile above the entrance to the lock. Work on this contract was started on October 5, 1901, and the first mattress, 400 by 600 feet, was successfully sunk on November 30, 1901. There was used in sinking this mattress 6,000 tons of rock.

The second mattress, 400 by 450 feet, was finished on January 8, 1902, and sunk January 29, 1902, but only partially weighted; the balance of the rock was placed on the mattress April 7, 1902. There was used in sinking this mattress 4,153 tons of rock.

The first of the mattresses was sunk at the place where the last cave occurred in the river bank, and the second one on the lower side of the last dike placed during the last work of bank protection. The most probable place for future caves in the bank will be above the first mattress and midway between the second mattress and the entrance to the lock, as at this place a portion of the old work has washed away.

Dredging in Bayou Plaquemine.—There is included in this contract approximately 1,027,500 cubic yards of excavation. Up to July 1, 1901, there had been taken out 364,230 cubic yards.

The work was shut down by contractors in June, 1901, to make repairs and alterations to their plant. One of the changes contemplated at that time was the installation of a pulsometer to pump over into Dardennes Bend the material which was brought to it in dump scows from along the bayou.

Work on this pulsometer continued until October, 1901, and then was discarded as a failure, and in its place was substituted a 10-inch centrifugal pump. This was placed in working condition late in November, 1901, and actual dredging resumed December 1, 1901. The centrifugal pump was only a partial success, as the excavated material brought to it is filled with roots and trash, and the time is nearly half consumed in clearing these obstructions from the suction.

The contractors again suspended work on June 4, 1902, and it is not known at this time what plant is to be used to finish the work. The following is a tabulated statement of work accomplished during the past fiscal year:

	Cubic yards.
July, 1901	(a)
August, 1901	(a)
September, 1901	(a)
October, 1901	(a)
November, 1901	(a)
December, 1901	6,100
January, 1902	7,000
February, 1902	5,500
March, 1902	2,200
April, 1902	7,000
May, 1902	9,000
June, 1902	1,600
Total	38,400

Flat Lake and Bay Natchez.—A contract was entered into with Charles Clarke & Co., on April 3, 1902, to excavate a channel 50 feet wide and 10 feet deep, with perpendicular sides, in Flat Lake and Bay Natchez, Louisiana, respectively, 1.9 and 7 miles in length; approximate amount of excavation, 377,000 cubic yards.

The contractors are at this time getting their plant ready to do this work.

Protection levee.—A contract was made with John Short for building a protection levee from the northeast corner of the lock to connect with the main levee system in front of the lock.

The contract contemplates the grading of the embankments on the north side of the lock down to an elevation of 48 feet lock datum, and with 18,000 cubic yards included in the contract, building the levee with 11,000 cubic yards, and placing the remainder immediately adjoining in the back fill behind the lock wall.

This work was started June 2, 1902, with 15 teams and wheel scrapers; about 6,000 cubic yards have been placed in the levee.

Real estate belonging to the United States.—It was found that in order to carry out the proposed plans of the approach to the Plaquemine lock it would be necessary to purchase a parcel of land on the north side of the approach, belonging to A. Wilbert Sons Lumber and Shingle Company; also a parcel of land on the south side belonging to P. H. Thompson, on which was a residence building.

The building was in the proposed levee line, and was moved on the back part of the lot, turned around, and its floor raised to the height of top of levee, and is now used as the engineer office at this point. It is now being painted, and will be available to the United States for whatever purpose required.

Very respectfully, your obedient servant,

J. I. Conklin,
Superintendent.

Lieut. Col. H. M. Adams,
Corps of Engineers.

T 10.

IMPROVEMENT OF BAYOU COURTABLEAU, LOUISIANA.

* * * * * * *

No work has been done during the past fiscal year, as the funds available would not permit.

No statistics for Bayou Courtableau for the calendar year 1901 could be obtained.

Money statement.

July 1, 1901, balance unexpended	$132.54
July 1, 1902, balance unexpended	132.54

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[a] No work.

ABSTRACT OF APPROPRIATIONS FOR IMPROVING BAYOU COURTABLEAU, LOUISIANA.

By act of Congress—	
Approved June 14, 1880	$7,500
Approved March 3, 1881	7,500
Approved July 5, 1884	4,000
Approved August 5, 1886	5,000
Passed August 11, 1888	5,000
Approved September 19, 1890	2,200
Passed August 18, 1894	5,000
Passed June 3, 1896	2,500
Appproved March 3, 1899	20,000
Total	58,700

T II.

IMPROVEMENT OF BAYOU TECHE, LOUISIANA.

* * * * * * *

A history of the progress of the work will be found in Annual Report of the Chief of Engineers for 1896, pages 1503 and 1504; see also Annual Report for 1897, page 1764, and Annual Report for 1899, page 2260.

* * * * * * *

No work has been done during the past two fiscal years, sufficient funds not being available. On June 30, 1901, the bayou was comparatively free from snags and wrecks, but that portion above New Iberia had shoaled to a depth of 3 feet at points; below New Iberia the depth was ample for the commerce of the locality.

It is proposed to apply the available balance to the credit of this improvement to maintenance by dredging to remove bars and other obstructions from the mouth of the bayou to St. Martinville, La.

Money statement.

July 1, 1901, balance unexpended	$161.72
Amount appropriated by river and harbor act approved June 13, 1902	7,500.00
	7,661.72
June 30, 1902, amount expended during fiscal year	20.00
July 1, 1902, balance unexpended	7,641.72
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement in addition to the balance unexpended July 1, 1902	10,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

ABSTRACT OF APPROPRIATIONS FOR IMPROVING BAYOU TECHE, LOUISIANA.

By act of Congress—	
Approved July 11, 1870	$17,500
Approved June 14, 1880	6,000
Approved March 3, 1881	20,000
Approved July 5, 1884	6,500
Approved September 19, 1890	5,000
Passed August 18, 1894	6,000
Passed June 3, 1896	10,000
Approved March 3, 1899	10,000
Approved June 13, 1902 (maintenance)	7,500
Total	88,500

COMMERCIAL STATISTICS.

[From January 1, 1901, to December 31, 1901.]

Vessels entering and departing.

Class.	Number.	Trips.	Net registered tonnage.
Steamers	21	514	42,516
Barges	5	154	15,092
Total	26	668	57,608

Draft of heaviest vessel: Light, 2.5 feet; loaded, 6.5 feet.

Shipments and receipts, by water.

Articles.	Tons.	Value.
SHIPMENTS.		
Lumber	5,900	$42,480
Sugar and molasses	40,437	2,837,200
Cotton and cotton-seed products	334	58,440
Rice	2,297	88,336
Total	48,968	3,026,456
RECEIPTS.		
Merchandise	11,675	875,000
Machinery	1,375	137,500
Sugar cane	59,650	208,775
Logs and cordwood	129,430	451,500
Cooperage	1,500	25,000
Feed stuffs and fertilizer	7,260	77,200
Sewer pipe, brick, and cement	575	3,500
Coal	75,150	338,000
Grand total	335,583	5,142,931

T 12.

IMPROVEMENT OF CHANNEL, BAY, AND PASSES OF BAYOU VERMILION, LOUISIANA.

* * * * * * *

No work has been done during the past two fiscal years, funds not being available. The most recent examination of the improvement, made January 22, 1901, showed some snags in the bayou, and that the piles in the bay had nearly all disappeared.

It is proposed to apply the funds appropriated by act of June 13, 1902, to removal of obstructions in the bayou from the mouth to the Southern Pacific Railroad bridge, or as far as funds available will permit.

It is estimated that $1,000 annually will be required for maintenance after completion of the improvement.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902 (allotted)	$9,000.00
July 1, 1902, balance unexpended	9,000.00

Abstract of appropriations for improving channel, bay, and passes of Bayou Vermilion, Louisiana.

By act of Congress—

Approved July 13, 1892	$7,500
Passed August 18, 1894	5,000
Passed June 3, 1896	1,000
Approved March 3, 1899	2,500
Approved June 13, 1902 (allotted)	9,000
Total	25,000

COMMERCIAL STATISTICS.

[From January 1, 1901, to December 31, 1901.]

Vessels entering and departing.

Steamers	3
Sailing vessels	3
Barges	2
Total	8

Draft of heaviest vessel: Light, 2 feet; loaded, 4 feet.

NOTE.—Steamers and barges engaged in a general towing business. No record of "number of trips" obtainable.

Shipments and receipts, by water.

Articles.	Tons.	Value.
SHIPMENTS.		
Cattle	750	$18,000
Cord wood	2,500	8,750
Cotton and cotton-seed products	1,825	165,300
Rice	2,800	113,800
Sugar and molasses	810	56,750
Sugar cane	13,000	45,500
Total	21,685	408,100
RECEIPTS.		
Merchandise	125	9,375
Machinery	250	25,000
Lumber	500	3,300
Coal, brick, and sand	8,825	52,350
Grand total	31,385	498,125

T 13.

IMPROVEMENT OF MERMENTAU RIVER AND TRIBUTARIES, LOUISIANA.

* * * * * * *

No work has been done during the past two fiscal years. The most recent examination of the improvements, made in January, 1901, showed that the brush dams in Mud Lake have been damaged by storms and settlement and do not effectively confine the current to the dredged channel, the depth of which was then 5 feet.

With the funds appropriated June 13, 1902, and balance remaining from former appropriation, it is proposed to restore the brush dams to their original condition, and to remove obstructions to navigation as may be necessary.

Money statement.

July 1, 1901, balance unexpended	$1,568.22
Amount appropriated by river and harbor act approved June 13, 1902 (allotted)	2,500.00
	4,068.22
June 30, 1902, amount expended during fiscal year	25.00
July 1, 1902, balance unexpended	4,043.22
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	2,500.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

ABSTRACT OF APPROPRIATIONS FOR IMPROVING MERMENTAU RIVER AND TRIBUTARIES, LOUISIANA.

By act of Congress—

Approved July 13, 1892	$7,500.00
Passed August 18, 1894	5,000.00
Passed June 3, 1896	5,000.00
Approved March 3, 1899	6,115.25
Approved June 13, 1902 (allotted)	2,500.00
Total	26,115.25

COMMERCIAL STATISTICS.

[From January 1, 1901, to December 31, 1901.]

Vessels entering and departing.

Class.	Number.	Trips.	Net registered tonnage.
Steamers	8	104	4,680
Sailing vessels	10	84	1,680
Total	18	188	6,360

Draft of heaviest vessel: Light, 3.5 feet; loaded, 5.5 feet.

Shipments and receipts, by water.

Articles.	Tons.	Value.
SHIPMENTS.		
Rice	12,800	$520,000
Cattle	190	7,600
Cotton and cotton-seed products	665	38,100
Cord wood	500	1,750
Total	14,155	567,450
RECEIPTS.		
Merchandise	960	72,000
Machinery	1,040	104,000
Lumber, brick, sand, and cement	3,330	18,875
Coal and fuel oil	8,800	44,600
Feed stuff and fertilizer	1,000	16,000
Hides and furs	6	10,000
Grand total	29,291	832,925

T 14.

IMPROVEMENT OF MOUTH AND PASSES OF CALCASIEU RIVER, LOUISIANA.

* * * * * * *

No work has been done during the fiscal year ending June 30, 1902, beyond the partial removal of a shell reef in the channel in Calcasieu Lake.

The river and harbor act approved June 13, 1902, appropriated $75,000 for this improvement. Under project approved July 3, 1902, it is proposed to apply $10,000 of this amount to redredging the channel through the lake to its original depth of 8 feet, and to expend $65,000 in repairing and extending the east jetty, based upon estimate submitted on page 1903 of the Annual Report of the Chief of Engineers for 1901. This estimate contemplated an extension of the east and west jetties to their originally projected length, 9,347 and 7,200 feet, respectively, at an aggregate cost of $307,681. A balance of $242,681 will now be required to complete the improvement.

It is estimated that $10,000 will be required for repair of the revetment of the lake channels, and that about $10,000 annually will be required for dredging to maintain these channels.

Money statement.

July 1, 1901, balance unexpended		$545.77
Amount appropriated by river and harbor act approved June 13, 1902		75,000.00
		75,545.77
June 30, 1902, amount expended during fiscal year		46.90
July 1, 1902, balance unexpended and available		75,498.87
July 1, 1902, amount covered by uncompleted contracts		450.00
Amount (estimated) required for completion of existing project		242,681.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$242,681.00	
For maintenance of improvement	20,000.00	
		262,681.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

ABSTRACT OF APPROPRIATIONS FOR IMPROVING MOUTH AND PASSES OF CALCASIEU RIVER, LOUISIANA.

By act of Congress—		By act of Congress—	
Approved June 10, 1872	$15,000	Approved July 13, 1892	$100,000
Approved March 3, 1881	15,000	Passed August 18, 1894	90,000
Passed August 2, 1882	10,000	Passed June 3, 1896	80,000
Approved July 5, 1884	6,500	Approved March 3, 1899	35,000
Of August 11, 1888	10,000	Approved June 13, 1902	75,000
Approved September 19, 1890	75,000	Total	511,500

COMMERCIAL STATISTICS.

[From January 1, 1901, to December 31, 1901.]

Vessels entering and departing.

Class.	Number.	Trips.	Net registered tonnage.
Steamers	7	472	16,848
Sailing vessels	23	245	7,590
Barges	6	19	2,082
Total	36	736	26,520

Draft of heaviest vessel: Light, 6.5 feet; loaded, 8 feet.

Shipments and receipts, by water.

Articles.	Tons.	Value.
SHIPMENTS.		
Lumber	5,548	$41,610
Rice	2,589	112,180
Cotton and cotton-seed products	1,090	36,300
Brick, cement, and sand	226	1,500
Coal and wood	2,000	7,000
Hides and fur	5	10,000
Total	11,458	208,590
RECEIPTS.		
Merchandise	2,587	194,025
Logs	125,000	550,000
Grand total	139,045	952,615

T 15.

IMPROVEMENT OF JOHNSONS BAYOU, LOUISIANA.

* * * * * * *

No work has been done during the fiscal year ending June 30, 1902.

Money statement.

July 1, 1901, balance unexpended	$238.65
July 1, 1902, balance unexpended	238.65

ABSTRACT OF APPROPRIATIONS FOR IMPROVING JOHNSONS BAYOU, LOUISIANA.

By act of Congress approved March 3, 1899	$2,500

COMMERCIAL STATISTICS.

[From January 1, 1901, to December 31, 1901.]

Vessels entering and departing.

Class.	Number.	Trips.
Steamers	3	312
Sailing vessels	1	15
Barges	1	50
Total	5	377

Draft of heaviest vessel: Light, 2 feet; loaded, 3 feet.

Shipments and receipts, by water.

Articles.	Tons.	Value.
SHIPMENTS.		
Merchandise	1,158	$16,947
Cotton and cotton-seed products	257	13,075
Wheat and corn, in bulk	7	165
Sugar and molasses	5	500
Meat and lard	12	620
Cattle	820	34,000
Total	2,259	65,307
RECEIPTS.		
Merchandise	100	12,000
Lumber, shingles, wood, etc	1,150	4,100
Sundries	53	967
Cattle	800	32,500
Oil, in bulk	1	15
Grand total	4,363	114,889

Number of passengers carried, 1,000.

T 16.

REMOVING WATER HYACINTHS FROM LOUISIANA WATERS.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$8,034.04
June 30, 1902, amount expended during fiscal year	549.58
July 1, 1902, balance unexpended	7,484.46
July 1, 1902, outstanding liabilities	53.25
July 1, 1902, balance available	7,431.21

ABSTRACT OF APPROPRIATIONS FOR REMOVING THE WATER HYACINTH, LOUISIANA.

By act of Congress approved March 3, 1899	[a]$36,000

T 17.

IMPROVEMENT OF MOUTHS OF SABINE AND NECHES RIVERS, TEXAS.

* * * * * * *

No work has been done on this improvement during the past two fiscal years.

The dredged channels gradually shoal and fill up. It is estimated that $4,000 will be required annually for maintenance by dredging.

* * * * * * *

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[a] Of this amount $25,000 was for construction of boat, $10,000 for operations, and $1,000 for log booms.

Money statement.

July 1, 1901, balance unexpended		$74.71
Amount appropriated by river and harbor act approved June 13, 1902		125,000.00
July 1, 1902, balance unexpended		125,074.71
Amount (estimated) required for completion of existing project		25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$25,000.00	
For maintenance of improvement	4,000.00	
		29,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

ABSTRACT OF APPROPRIATIONS FOR IMPROVING MOUTHS OF SABINE AND NECHES RIVERS, TEXAS.

By act of Congress approved March 3, 1899	$10,000
By act of Congress approved June 13, 1902	125,000
Total	135,000

COMMERCIAL STATISTICS.

Statistics for the Neches River for the calendar year 1901 could not be obtained. For statistics concerning the Sabine River see report for that work.

T 18.

IMPROVEMENT OF SABINE RIVER, TEXAS.

* * * * * * *

No work has been done during the past fiscal year, sufficient funds not being available.

In connection with this work see report for "Improvement of Mouths of Sabine and Neches Rivers, Texas."

Money statement.

July 1, 1901, balance unexpended	$161.67
July 1, 1902, balance unexpended	161.67

ABSTRACT OF APPROPRIATIONS FOR IMPROVING SABINE RIVER, TEXAS.

Allotted from act approved June 10, 1872	$2,700.00
By act of Congress—	
Approved June 18, 1878	10,000.00
Approved March 3, 1879	6,000.00
Approved June 14, 1880	5,000.00
Approved March 3, 1881	7,000.00
Passed August 2, 1882	4,000.00
Approved July 13, 1892	5,000.00
Passed August 18, 1894	5,000.00
Passed June 3, 1896	2,000.00
Approved March 3, 1899 (maintenance)	2,000.00
Amount allotted by sundry civil act of March 2, 1895, from appropriation of August 18, 1894, for improving Sabine Pass, Texas	[a]4,000.00
Total	52,700.00

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[a] The above amount was allotted for dredging bar across the mouth of Sabine River. The work was done by Government dredge and hired labor.

COMMERCIAL STATISTICS.

[From January 1, 1901, to December 31, 1901.]

Vessels entering and departing.

Class.	Number.	Trips.	Net registered tonnage.
Steamers	6	601	9,060
Sailing vessels	12	260	7,800
Barges	11	264	52,800
Total	29	1,128	69,660

Draft of heaviest vessel: Light, 5.6 feet.

Shipments and receipts, by water.

Articles.	Tons.	Value.
SHIPMENTS.		
Lumber	24,383	$158,493
Merchandise	1,440	69,815
Rice	1,480	59,200
Shell	2,000	400
Sand	10,000	2,000
Fresh water	1,600	3,000
Total	40,903	292,908
RECEIPTS.		
Cattle	3,100	186,000
Rice	2,200	88,000
Steel	2,709	94,640
Logs	410,782	1,314,504
Machinery	215	24,000
Grand total	459,909	2,000,052

T 19.

IMPROVEMENT OF HARBOR AT SABINE PASS, TEXAS.

* * * For a detailed history of the progress of the work see Reports of the Chief of Engineers for 1896, pages 1512–1514; for 1897, page 1771; for 1898, page 1482; for 1899, page 1858; for 1900, page 2276, and for 1901, page 1910.

The work done during the past fiscal year consisted of dredging in the harbor (main ship channel), under contract with the Rittenhouse-Moore Dredging Company, and dredging between the jetties with the U. S. dredge *Sabine*.

Dredging in the main ship channel opposite Sabine was provided for by an appropriation of $150,000 made by the river and harbor act of March 3, 1899, and has been carried on under project approved by the Secretary of War March 27, 1899. A contract for doing the work was made July 27, 1899, with the Rittenhouse-Moore Dredging Company, to be completed March 31, 1901. The contractor has been very dilatory in executing this work. Work was done in April, 1900, resulting in the removal of 1.414 cubic yards. Nothing further was done until August, 1900, in which month 7,388 cubic yards were removed. The work was again suspended until March 20, 1901. on which date operations were resumed with a different plant. No work was done in July and August, 1901; the dredge was undergoing repairs at Galveston until August 8, and afterwards was engaged in recovering the steamer *Roma* at Galveston, under permission given the contractor by the Chief of Engineers. On June 20, 1902, the dredge was disabled by an accident, and it is not known when work will be resumed. The contractor has been directed to proceed with the work. During the year 603,563 cubic yards were removed, making a total of 822,836 cubic yards since commencement of work out of approximately 1,421,050 cubic yards, or about six-tenths of the work contracted for. The time for completion of the contract was extended one year on March 21, 1901; by authority of the Chief of Engineers the time for completion was waived on April 28, 1902, for a reasonable period.

The U. S. dredge *Sabine*, completed in January, 1901, was operated in the channel between the jetties from February 8 to June 30, 1901, and removed 198,800 cubic yards of material in 110 days' work. The jetty channel had an available depth of 22.5 feet on June 30, 1901. The *Sabine* was absent in use at South Pass, Mississippi River, and undergoing repairs at New Orleans from July 1 to October 27, 1901. It resumed operations in the jetty channel at Sabine Pass October 28, 1901, and continued until January 15, 1902, when funds were exhausted; 165,140 cubic yards of material were removed. For this last work $2,000, allotted October 14, 1901, from appropriations for emergencies in rivers and harbors, was expended. On January 16 the *Sabine* left for South Pass, from whence it proceeded to New Orleans, and was docked and repaired February 10. It returned to Sabine Pass on February 15, and resumed operations in the jetty channel February 17, removing 152,555 cubic yards of material to June 30, 1902. The expenses of this work to and including June 13, 1902, were paid from funds advanced by the Kansas City Southern Railway Company, under authority of the Assistant Secretary of War. Its operation resulted in increasing the available depth between the jetties from 19.7 feet to 22 feet.

The river and harbor act approved June 13, 1902, appropriated $185,000 for this improvement. It is proposed, under project approved July 3, 1902, to apply $100,000 of this amount to repairing damages and restoring the jetties to their original height, as indicated in report dated September 25, 1900, printed in Report of the Chief of Engineers for 1901, page 1919, and in House Doc. No. 152, Fifty-sixth Congress, second session; to expend $60,000 in making necessary repairs to the dredge *Sabine* and expenses of operation in the channel between the jetties for approximately two years; and to expend $25,000 in dredging in Sabine Pass Harbor in accordance with the provisions of the act and the estimate of cost given in House Doc. No. 70, Fifty-sixth Congress, second session.

It is also proposed to apply the balance of the appropriation made by the river and harbor act of March 3, 1899, to a continuation of dredging in the harbor, under project approved by the Secretary of War March 27, 1899.

A revised estimate of $1,116,573 for cost of completing the jetties to their original projected length and height and for making repairs was submitted in Annual Report of the Chief of Engineers for 1901 (p. 1912). After applying $100,000 of the funds appropriated by act of June 13, 1902, to repairs, the further sum of $1,016,573 will be required for completion of the jetties.

It is believed that a 25-foot depth in the jetty channel can not be maintained until the jetties are raised to the level of mean high water.

The sum of $30,000 per annum will be required for operating the dredge *Sabine* in channel between the jetties.

Money statement.

July 1, 1901, balance unexpended	$143,300.54
Amount allotted from appropriation "Emergency in River and Harbor Works," act June 6, 1900	2,000.00
Amount appropriated by river and harbor act approved June 13, 1902.	185,000.00
	330,300.54
June 30, 1902, amount expended during fiscal year	68,746.77
July 1, 1902, balance unexpended	261,553.77
July 1, 1902, outstanding liabilities	11,798.42
July 1, 1902, balance available	249,755.35
July 1, 1902, amount covered by uncompleted contracts	56,830.57
Amount (estimated) required for completion of existing project	1,016,573.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	1,016,573.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

ABSTRACT OF APPROPRIATIONS FOR IMPROVING HARBOR AT SABINE PASS, TEXAS.

From act approved August 30, 1852 (survey)	$5,000.00
Allotted from act approved June 10, 1873 (survey)	2,000.00
By act of Congress—	
Approved March 3, 1875	20,000.00
Approved August 14, 1876	38,000.00
Approved June 18, 1878 (allotted)	30,000.00
Approved March 3, 1879	25,000.00
Approved June 14, 1880	50,000.00
Approved March 3, 1881	150,000.00
Passed August 2, 1882	150,000.00
Approved July 5, 1884	200,000.00
Approved August 5, 1886	198,750.00
Of August 11, 1888	250,000.00
Approved September 19, 1890	300,000.00
Approved July 13, 1892	350,000.00
Of August 18, 1894	[a]271,000.00
Of June 3, 1896	75,000.00
Approved June 4, 1897 (sundry civil)	480,000.00
Approved July 1, 1898 (sundry civil)	400,000.00
Approved March 3, 1899 (sundry civil)	264,000.00
Approved March 3, 1899 (river and harbor)	150,000.00
Approved June 6, 1900 (sundry civil)	36,000.00
Approved June 6, 1900 (emergencies in river and harbor works, allotted)	10,000.00
Approved June 13, 1902 (river and harbor)	185,000.00
Total	3,639,750.00
Reverted to Treasury from act of June 4, 1897	16,297.03
Total	3,623,452.97

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[a] The total amount of this appropriation was originally $275,000, but of this sum $4,000 was allotted by sundry civil act of March 2, 1895, for dredging through a bar across the mouth of Sabine River, Texas, and was expended on that improvement.

ABSTRACT OF CONTRACT IN FORCE DURING YEAR ENDING JUNE 30, 1902, FOR IMPROVING HARBOR AT SABINE PASS, TEXAS.

For dredging main ship channel.

Name and address of contractor.	Dated.	Approved.	Date of beginning.	Date of expiration.
Rittenhouse Moore Dredging Co., Mobile, Ala	July 27, 1899	Sept. 22, 1899	Nov. 22, 1899	[a] Mar. 31, 1901

[a] Extended to Mar. 31, 1902, and waived on that date.

For the removal of about 1,421,050 cubic yards of material, at 9½ cents per cubic yard, amounting to about	$135,000.00
To June 30, 1902, 822,836 cubic yards had been removed, amounting to	78,169.42
Balance remaining to be done July 1, 1902, about 598,216 cubic yards, amounting to	56,830.58

REPORT OF FIRST LIEUT. PAUL S. BOND, CORPS OF ENGINEERS.

SABINE, TEX., *June 30, 1902.*

SIR: The work in the Sabine Pass and harbor during the past fiscal year consisted of dredging in the main ship channel, under contract with the Rittenhouse Moore Dredging Company, and dredging in the channel between the jetties by the dredge *Sabine.*

The Rittenhouse Moore Dredging Company began work in the main ship channel on September 5, 1901, with hydraulic dredge and rotary cutter attachment, pumping the material ashore through a pipe line. During the year the contractor has removed 602,149 cubic yards of solid material in place. The amount remaining to be done, as contemplated in the act of March 3, 1899, consists of four cuts, each 100 feet wide, and 2,790, 3,900, 4,470, and 4,964 feet long, respectively. The total amount removed by the contractor since commencing work is 822,836 cubic yards; 598,214 cubic yards remain to be removed under contract.

The dredge *Sabine* began work in the channel between jetties on October 27, 1901, and operated continuously until January 16, 1902, when the available funds being exhausted, the dredge ceased work and repaired to New Orleans, La.

From February 17 to June 30, 1902, the dredge was employed between the jetties in Sabine Pass, the expenses of operation to June 13 being paid from funds advanced by the Kansas City Southern Railway, under authority of the Secretary of War.

The following tables show the operations of the dredge *Sabine* during the year ending June 30, 1902, and the condition of the channel between the jetties, as indicated by soundings taken on June 29, 1901, and June 21, 1902:

Table showing work performed by the dredge Sabine in Sabine Pass during the year.

	Loads dredged.
October 27 to 31, 1901	59
November, 1901	342
December 1 to 16, 1901	314
January, 1902	146
February 17 to 30, 1902	55
March, 1902	132
April, 1902	131
May, 1902	130
June, 1902	142
Total loads removed from channel at Sabine Pass, Tex ... loads	2,451
Multiply by 325 cubic yards, capacity of bins per load ... cubic yards	471,575
Multiply by 60 per cent proportion of solid material ... do	282,945

This material was deposited 1 mile to westward of end of west jetty.

Table showing change in the condition of the channel during the year.

[Soundings taken June 29, 1901.]

Buoy.	To buoy.	Distance.	Average depth.	Minimum depth.	Maximum depth.
		Feet.			
Bell	2	2,300	23.4	21.5	24.5
2	4	1,300	22.7	21.5	23.3
4	6	2,000	22.9	22.5	23.5
6	8	1,600	22.7	21.8	23
8	8A	3,600	24.5	21.8	27
8A	10	3,300	22.8	22	23.4
10	12	2,300	22.2	21.5	23
12	12A	1,600	23.5	22	24.2
12A	14	2,050	22.9	22	23.5
14	14A	2,200	22.6	21.8	23.5
14A	16	1,750	22.8	21.5	24.4

[Soundings taken June 21, 1902.]

Bell	2	2,300	22.2	21.7	23.4
2	4	1,300	22.3	21.9	22.7
4	6	2,000	22	21.7	22.7
6	8	1,600	22.2	21.7	22.7
8	8A	3,600	22.5	21.6	23.6
8A	10	3,300	22.3	21.6	23.6
10	12	2,300	22.6	21.8	23.9
12	12A	1,600	23.2	22.6	24.3
12A	14	2,050	23.7	22.5	24.4
14	14A	2,200	23.6	22.8	24.5
14A	16	1,750	23.8	22.6	25.3

At the end of the last fiscal year (ending June 30, 1901) the available depth of the channel at mean low water was regarded as 21.5 feet. The present available depth of the channel is regarded as being 22 feet at mean low water, notwithstanding the fact that occasional soundings less than 22 feet are obtained (see table). The bottom, however, being soft mud, it is considered that these lumps would not interfere with the progress of a large vessel. At high tide vessels drawing 23 feet, or even more, can enter the harbor.

The great amount of work required to maintain the channel is possibly caused by the current carrying sediment, which flows through the three gaps in the east jetty made by the storm of September 8, 1900.

The condition of the jetties is substantially the same as it was a year ago.

The following surveys have been made during the year: February 13, 1902, hydrographic survey of channel between the jetties, from head of channel to end of jetties; February 28, 1902, hydrographic survey of channel between the jetties, from head of channel to 25-foot contour in the Gulf of Mexico.

Very respectfully, your obedient servant,

Paul S. Bond,
First Lieutenant, Corps of Engineers.

Lieut. Col. H. M. Adams,
Corps of Engineers.

APPENDIX U.

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN TEXAS.

REPORT OF CAPT. C. S. RICHÉ, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. **Galveston Harbor, Texas.**
2. **Galveston channel, Texas.**
3. **Channel from Galveston Harbor to Texas City, Texas.**
4. **Galveston Ship channel and Buffalo Bayou, Texas.**
5. **Operation and care of Morgans Canal, Texas.**
6. **Trinity River, Texas.**
7. **Brazos River between Velasco and Richmond, West Galveston Bay channel, Double Bayou, and the mouths of the adjacent streams.**
8. **Trinity River, Texas.**
9. **Cedar Bayou, Texas.**
10. **Channel in West Galveston Bay, Texas.**
11. **Brazos River, Texas.**
12. **Brazos River, Texas, from Richmond to Old Washington.**
13. **Mouth of Brazos River, Texas.**
14. **Aransas Pass, Texas.**
15. **Harbor at Brazos Santiago, Texas.**
16. **Removing sunken vessels or craft obstructing or endangering navigation.**

EXAMINATION AND SURVEY.

17. **Inner harbor at Galveston, Texas.**

HARBOR LINES.

18. **Lavaca Bay at Port Lavaca, Texas.**

United States Engineer Office,
Galveston, Tex., July 18, 1902.

General: I have the honor to forward herewith annual reports for the works of river and harbor improvements in my charge for the fiscal year ending June 30, 1902.

Very respectfully, your obedient servant,

C. S. Riché,
Captain, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

U 1.

IMPROVEMENT OF GALVESTON HARBOR, TEXAS.

* * * * * * *

DREDGING.

A description of the U. S. dredge *Gen. C. B. Comstock* will be found on pages 1530–1531, Annual Report of the Chief of Engineers for 1896.

During the first half of July, 1901, the dredge was laid up for minor repairs. From July 15 to September 15, 1901, by permission of the Secretary of War, the dredge was operated by the Galveston Wharf Company, of Galveston, Tex., in dredging the channel in front of their wharves. The wharf company paid all expenses of operating the dredge and a rental of $50 per day. The total amount received for this rental from the Galveston Wharf Company was $3,050, which was deposited into the Treasury of the United States.

Owing to the injuries sustained during the hurricane of September 8, 1900, the dredge had to be thoroughly overhauled and repaired during the year. Repairs were completed on January 7, 1902, and dredge resumed active operations.

On February 9, 1902, the dredge was temporarily transferred to the Montgomery, Ala., district for work at Pensacola, Fla. The dredge reported back to Galveston on June 15, 1902.

During the year the dredge excavated, removed, and dumped from Galveston Harbor 181,485 cubic yards of material, of which 102,106 cubic yards was from channel in front of wharves, and 79,379 cubic yards was from outer and inner bar channel.

At close of fiscal year dredge is having oil-burning apparatus installed for the burning of oil as fuel. It is estimated that the use of oil as fuel in place of coal will reduce the operating expenses of the dredge from $500 to $1,000 per month.

A detailed account of the work done during the fiscal year will be found in the report of Mr. E. M. Hartrick, assistant engineer, forwarded herewith, to which attention is invited.

STORMS.

The report of Mr. E. M. Hartrick, assistant engineer, gives detailed description of the storms during the year.

RESURVEY OF GALVESTON BAY.

A table giving the rectangular coordinates in meters, yards, and feet of all survey marks in Galveston Bay and vicinity, as well as the coordinates of all points on the harbor lines, is appended hereto. These coordinates are available for use in the artillery work connected with the fortifications, as well as in all surveys for harbor and channel work. They are appended hereto with a view of rendering them easily available for general use.

SURVEYS.

The report of Mr. E. M. Hartrick, assistant engineer, gives detailed description of the surveys during the year. Attention is also invited to the map submitted with this report.

Prior to the hurricane of September 8, 1900, the action of the jetties alone was steadily improving the channel, and less and less dredging was becoming necessary. The lowering of the jetties by this hurricane, however, permits the escape over them of much tidal energy. The tidal flow, especially during excessive tides, is no longer completely confined, and as a result there is much less scouring force available for the outer bar. Dredging will have to be continued from time to time therefore to maintain existing channel depths, and would have to be prosecuted vigorously to increase these depths. When the jetties are repaired, however, the necessity for dredging will again diminish.

The river and harbor act approved June 13, 1902, appropriated $350,000 for maintaining the entrance to the harbor and toward the restoration of the jetties, in accordance with the report submitted in House Doc. No. 134, Fifty-sixth Congress, second session, and authorized the letting of a contract in the sum of $400,000, exclusive of amounts appropriated. Project for expenditure of this appropriation has been submitted.

Total amount expended on this improvement to June 30, 1902, $8,519,684.42.

Money statement.

July 1, 1901, balance unexpended		$52,433.08
Amount appropriated by river and harbor act approved June 13, 1902		350,000.00
		402,433.08
June 30, 1902, amount expended during fiscal year		43,097.67
July 1, 1902, balance unexpended		359,335.41
July 1, 1902, outstanding liabilities		4,390.08
July 1, 1902, balance available		354,945.33
Amount (estimated) required for completion of existing project		1,150,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$400,000.00	
For maintenance of improvement	50,000.00	
		450,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

ABSTRACT OF APPROPRIATIONS MADE BY CONGRESS FOR IMPROVING HARBOR AT GALVESTON, TEX.

By act of—		By act of—	
July 11, 1870	$25,000	September 19, 1890	$500,000
March 3, 1871	20,000	March 3, 1891	600,000
June 10, 1872	31,000	August 5, 1892	450,000
June 23, 1874	60,000	March 3, 1893	1,000,000
March 3, 1875	150,000	August 18, 1894	600,000
August 14, 1876	142,000	January 25, 1895	200,000
June 7, 1878	75,000	March 2, 1895	1,160,000
June 18, 1878	50,000	February 26, 1896	300,000
March 3, 1879	100,000	June 3, 1896	50,000
June 14, 1880	175,000	June 11, 1896	840,000
March 3, 1881	250,000	June 4, 1897	500,000
March 4, 1882	100,000	March 3, 1899	50,000
August 2, 1882	300,000	June 13, 1902	350,000
August 5, 1886	300,000		
August 11, 1888	500,000	Total	8,878,000

In addition to the above appropriations by Congress, there has been collected from the steamship *Maratime* $300, and from Quartermaster's Department, United States Army, $719.83, making a total of $8,879,019.83.

COMMERCIAL STATISTICS OF GALVESTON HARBOR, TEXAS, FOR FISCAL YEAR ENDING JUNE 30, 1902.

Tonnage of vessels and revenue collected.

	Steam vessels.	Sailing vessels.	Total.	Total tonnage.
Entered	534	129	663	1,190,721
Cleared	542	190	732	1,214,243
Total	1,076	319	1,395	2,404,964

Duties on imports collected	$180,611
All moneys collected at custom-house	220,320

Amount and value of freight entered and cleared.

Articles.	Tons.	Approximate value.	Articles.	Tons.	Approximate value.
Cotton	589,956	$96,759,263	Lumber and timber	92,237	$740,636
Cotton products	189,562	5,752,712	Cement	19,781	300,177
Ore	66,210	908,161	Petroleum	150,797	394,713
Wool	13,244	3,991,106	Fuel oil	14,064	38,560
Grain	298,326	7,251,112	Steel rails and fastenings	11,735	352,050
Sugar	2,900	286,891	Cattle, horses, etc	2,147	145,993
Coal	107,178	536,205			
General merchandise	227,557	142,855,671			
Flour	14,283	524,104	Total	1,799,977	260,837,354

RECTANGULAR COORDINATES.

Triangulation stations, beacons, harbor lines, etc., Galveston Bay, Texas, and vicinity.

[Axes: True meridian at north base, east and west line at north base. For each station or point the upper figures are meters, the middle figures yards, and the lower figures feet.]

Station.	North.	South.	East.	West.
Hospital		11,881.438	11,284.626	
		12,993.666	12,341.000	
		38,981.000	37,023.000	
Medical college		11,904.879	11,170.678	
		13,019.305	12,216.376	
		39,057.916	36,649.130	
Market		12,076.272	11,022.390	
		13,206.742	12,054.206	
		39,620.229	36,162.620	
East Broadway		12,605.700	11,801.815	
		13,785.403	12,906.592	
		41,356.219	38,719.785	
Elevator A		11,694.660	10,582.624	
		12,789.407	11,573.272	
		38,368.221	34,719.824	
North spire		12,726.569	10,049.180	
		13,917.910	10,989.891	
		41,753.730	32,969.680	
Electric chimney		12,926.958	10,192.554	
		14,137.050	11,146.687	
		42,411.151	33,440.062	
Ball High School		12,877.925	10,011.175	
		14,083.438	10,948.330	
		42,250.320	32,845.000	
Weather signal		12,650.400	9,780.767	
		13.834.614	10,696.352	
		41,503.847	32,089.059	
Tremont Hotel		12,752.917	9,775.586	
		13,946.733	10,690.687	
		41,840.200	32,072.066	
Transit 1895		12,839.595	9,998.096	
		14,041.520	10,934.025	
		42,124.563	32,802.083	
Custom-house		12,880.442	9,531.448	
		14,086.198	10,423.693	
		42,258.582	31,271.079	

Triangulation stations, beacons, harbor lines, etc., Galveston Bay, Texas, etc.—Continued.

Station.	North.	South.	East.	West.
Elevator B	....	12,416.428	9,002.773	....
		13,578.740	9,845.530	....
		40,736.210	29,536.600	....
Brewery chimney	....	13,055.033	8,605.986	....
		14,277.125	9,411.600	....
		42,831.382	28,234.800	....
St. Patrick's spire	....	13,633.727	8,695.136	....
		14,910.000	9,509.072	....
		44,730.000	28,527.217	....
Cot	....	13,392.255	7,859.783	....
		14,645.915	8,595.543	....
		43,937.747	25,786.630	....
Stand pipe	....	13,211.386	8,973.617	....
		14,448.116	9,813.643	....
		43,344.348	29,440.930	....
City Beach	....	16,145.072	7,746.689	....
		17,656.422	8,471.863	....
		52,969.268	25,415.590	....
15-pounder Crockett	....	16,200.946	7,716.039	....
		17,717.530	8,438.341	....
		53,152.590	25,315.023	....
Gun	....	15,987.130	7,993.347	....
		17,483.705	8,741.610	....
		52,451.096	26,224.831	....
West Broadway	....	14,380.917	5,891.879	....
		15,727.126	6,443.273	....
		47,181.391	19,329.822	....
Beach chimney	....	14,370.966	10,203.221	....
		15,716.282	11,158.350	....
		47,148.848	33,475.054	....
Gulf	....	11,317.098	12,430.796	....
		12,376.500	13,594.454	....
		37,129.500	40,783.367	....
Fence	....	10,128.624	13,356.592	....
		11,076.774	14,606.922	....
		33,230.323	43,820.767	....
Center	....	10,000.145	12,456.978	....
		10,936.267	13,623.078	....
		32,808.803	40,869.245	....
Bolt	....	9,905.801	11,779.551	....
		10,833.095	12,882.243	....
		32,499.283	38,646.734	....
Q. F	....	9,863.062	11,662.668	....
		10,786.350	12,739.744	....
		32,359.052	38,219.236	....
Mort	....	9,944.479	13,251.345	....
		10,875.397	14,491.816	....
		32,626.177	43,475.450	....
Case	....	9,825.873	11,741.465	....
		10,745.681	12,840.600	....
		32,237.044	38,521.800	....
15-pounder S. J	....	9,153.363	13,831.861	....
		10,010.214	14,579.869	....
		30,030.648	43,739.610	....
4".7 S. J	....	9,425.148	13,634.448	....
		10,307.444	14,910.777	....
		30,922.335	44,732.340	....
Fort Point light-house	....	9,113.423	12,343.096	....
		9,966.766	13,498.543	....
		29,900.300	40,495.630	....
Red beacon	....	10,561.436	11,028.590	....
		11,550.100	12,060.980	....
		34,650.301	36,182.950	....
M	....	8,619.461	8,773.608	....
		9,426.335	9,594.913	....
		28,279.014	28,784.748	....
O	....	7,272.138	6,777.626	....
		7,952.890	7,412.085	....
		23,858.670	22,236.205	....
G. G	....	7,451.783	12,342.145	....
		8,149.351	13,813.000	....
		24,448.055	41,439.000	....
4 S. jetty	....	9,353.350	14,080.214	....
		10,228.924	15,398.276	....
		30,686.780	46,194.830	....
3 S. jetty	....	9,567.158	15,630.628	....
		10,462.750	17,093.831	....
		31,388.252	51,281.494	....
2 S. jetty	....	9,792.442	17,268.149	....
		10,709.121	18,884.635	....
		32,127.363	56,653.890	....

Triangulation stations, beacons, harbor lines, etc., Galveston Bay, Texas, etc.—Continued.

Station.	North.	South.	East.	West.
South jetty		10,099.576	19,572.846	
		11,045.007	21,385.369	
		33,135.023	64,156.120	
South jetty (old)		10,093.022	19,576.043	
		11,953.407	21,408.572	
		35,860.223	64,225.794	
R		8,785.347	17,460.233	
		9,607.750	19,094,730	
		28,823.253	57,284.210	
R (old)		9,062.197	18,025.403	
		9,910.516	19,712.777	
		29,731.554	59,138.338	
North jetty		8,114.850	20,857.785	
		8,874.488	22,810.300	
		26,623.466	68,430.906	
North jetty (old)		8,124,678	20,976.820	
		8,855.200	22,940.482	
		26,655.600	68,821.445	
North jetty light		7,876.643	19,447.306	
		8,613.981	21,267,777	
		25,841.952	63,803.382	
Bar gauge		7,610.915	19,042.376	
		8,323.377	20,824.952	
		24,970.137	62,474.858	
Gamma		7,342.598	17,953.356	
		8,029.946	19,633.936	
		24,089.938	58,901.960	
Gamma (old)		7,300.715	17,856.858	
		7,984.141	19,528.450	
		23,952.242	58,585.365	
Beta		6,758.273	16,430.075	
		7,390.920	17,968.107	
		22,172.760	53,904.321	
Alpha		6,037.702	14,765.746	
		6,602.900	16,147.982	
		19,808.700	48,443.944	
4 E		6,190.176	13,171.283	
		6,769.642	14,404.202	
		20,308.930	43,212.610	
Light-house		5,778.205	12,343.011	
		6,319.110	13,498.450	
		18,957.330	40,495.355	
15-pounder Travis		6,290.442	12,911.593	
		6,879.296	14,120.256	
		20,637.890	42,360.774	
8-inch Travis		6,136.316	13,237.803	
		6,710.742	14,477.003	
		20,132.226	43,431.020	
Tank		5,993.868	10,784.005	
		6,554.959	11,793.500	
		19,664.879	35,380.511	
Lower beacon		3,616.730	8,026.059	
		3,955.296	8,777.386	
		11,865.888	26,332.163	
Lower beacon (old)		4,951.735	10,435.103	
		5,415.271	11,111.942	
		16,245.812	34,235.827	
Baffle Point		2,643.335	12,067.124	
		2,890.778	13,537.480	
		8,672.336	40,612.440	
P		2,955.626	16,378,679	
		3,232.304	17,911.901	
		9,696.913	53,735.712	
S		429.119	18,992.987	
		469.289	20,770.933	
		1,407.867	62,312.800	
West Bay Point		13,470.310	4,556.735	
		14,731.276	4,983.300	
		44,193.836	14,949.900	
West Bay 1		16,277.446	884.337	
		17,788.900	967.120	
		53,366.700	2,901.362	
West Bay 2		13,817.950		1,776.555
		15,111.460		1,912.860
		45,334.385		5,828.578
West Bay 3		18,592.474		3,079.698
		20,332.940		3,367.993
		60,998.820		10,103.996
West Bay 4		15,103.174		7,571.348
		16,516.992		8,280.108
		49,550.977		24,840.325

Triangulation stations, beacons, harbor lines, etc., *Galveston Bay, Texas, etc.*—Continued.

Stations.	North.	South.	East.	West.
West Bay 5		22,918.404		7,258.305
		25,063.815		7,937.760
		75,191.456		23,813.285
West Bay 6		19,844.286		11,784.309
		21,701.920		12,887.440
		65,105.776		38,662.321
West Bay 6 (old)		20,125.326		12,299.018
		22,009.274		13,373.784
		66,027.830		40,121.357
West Bay 7		26,235.227		12,437.975
		28,691.125		13,602.304
		86,073.392		40,806.915
West Bay D		23,430.114		14,631.440
		25,623.426		16,001.100
		76,870.285		48,003.300
West Bay B		17,688.551		9,677.687
		19,344.392		10,583.624
		58,033.186		31,750.875
West Bay A		20,918.806		5,400.688
		22,877.021		5,906.251
		68,631.078		17,718.755
West Bay C		24,758.406		9,937.837
		27,076.062		10,868.127
		81,228.190		32,604.383
West Bay E		22,698.740		15,662.293
		24,823.577		17,128.450
		74,470.741		51,385.357
Virginia Point		11,393.291	320.217	
		12,459.828	350.193	
		37,379.483	1,050.579	
South base		9,806.702		1,950.416
		10,724.713		2,132.996
		32,174.141		6,398.990
Texas City chimney		4,846.111		15.278
		5,299.759		16.708
		15,899.278		50.124
Texas City Hotel		3,820.127		715.933
		4,177.732		782.952
		12,533.199		2,348.856
Shoal Point		2,706.050	102.984	
		2,959.365	112.624	
		8,878.100	337.873	
Half Moon light-house		2,111.636	4,280.329	
		2,309.308	4,681.016	
		6,927.925	14,043.045	
North base	0.	0.	0.	0.
Dollar Point	1,589.788		316.149	
	1,738.609		345.744	
	5,215.828		1,037.232	
Millers Point	3,228.787			2,384.532
	3,531.035			2,607.750
	10,593.109			7,823.250
Heron Grove	83.985			2,841.821
	91.847			3,107.846
	275.541			9,323.539
Dickinson	4,633.800			7,748.596
	5,067.574			8,473.966
	15,202.725			25,421.848
April Fool Point	5,160.626			3,266.724
	5,643.716			3,572.525
	16,931.141			10,717.576
Dollar Point shoal	4,324.891		2,476.453	
	4,729.747		2,708.276	
	14,189.242		8,124.828	
Hannas Island	5,350.017		6,268.993	
	5,850.837		6,855.840	
	17,552.512		20,567.520	
Sh. Ch. 4	1,379.571		6,756.482	
	1,508.714		7,388.960	
	4,526.142		22,166.887	
Sh. Ch. 5	2,932.117		5,856.300	
	3,206.595		6,404.513	
	9,619.785		19,213.540	
Sh. Ch. 6	4,540.161		4,910.814	
	4,965.169		5,370.518	
	14,895.507		16,111.555	
Sh. Ch. 7	6,101.474		4,006.650	
	6,672.637		4,381.716	
	20,017.912		13,145.148	
Sh. Ch. 8	7,719.453		3,067.012	
	8,442.077		3,354.118	
	25,326.232		10,062.354	

Triangulation stations, beacons, harbor lines, etc., Galveston Bay, Texas, etc.—Continued.

Station.	North.	South.	East.	West.
South beacon	8,868.569		2,327.085	
	9,698.762		2,544.867	
	29,096.282		7,634.600	
South tide gauge	9,749.384		2,672.043	
	10,662.033		2,922.176	
	31,981.030		8,766.528	
Opossum Pass	11,411.091		6,633.823	
	12,479.293		7,254.821	
	37,437.879		21,764.465	
Red Fish light-house (old)	10,334.607		2,358.667	
	11,301.930		2,579.464	
	33,905.790		7,738.391	
Red Fish light-house (new)	9,917.507		1,785.212	
	10,845.887		1,952.327	
	32,537.662		5,856.970	
North tide gauge	10,561.929		1,946.791	
	11,550.636		2,129.032	
	34,651.911		6,387.096	
North beacon	11,363.398		744.104	
	12,427.774		813.760	
	37,283.334		2,441.276	
Sh. Ch. 11	12,439.855		93.914	
	13,604.334		102.705	
	40,813.009		308.116	
Sh. Ch. 12	13,987.457			945.838
	15,296.829			1,034.379
	45,890.489			3,103.136
Sh. Ch. 13	15,522.890			1,977.193
	16,976.000			2,162.279
	50,928.000			6,486.840
Sh. Ch. 14	17,093.172			3,034.888
	18,693.275			3,319.063
	56,079.827			9,957.190
Sh. Ch. 15	18,513.756			3,988.560
	20,246.842			4,361.965
	60,740.534			13,085.899
Sh. Ch. 16	20,051.979			5,023.021
	21,929.066			5,493.230
	65,787.198			16,479.690
Morgan beacon	20,873.613			5,648.511
	22,827.608			6,177.257
	68,482.828			18,531.773
Edwards Point	8,472.899			1,588.556
	9,266.055			1,737.265
	27,798.166			5,211.798
Rock Springs	10,031.280			7,431.939
	10,970.315			8,127.650
	32,909.470			24,382.954
Flanders	13,102.117			11,500.765
	14,328.600			12,577.356
	42,985.800			37,732.078
Morris	16,369.500			11,510.520
	17,901.843			12,588.032
	53,705.530			37,764.095
Red Bluff, west	17,943.688			10,311.018
	19,623.413			11,276.239
	58,870.244			33,828.721
Red Bluff	20,321.866			8,621.026
	22,224.210			9,428.020
	66,672.630			28,284.064
Red Bluff, north	21,010.589			9,266.137
	22,977.430			10,133.548
	66,932.286			30,400.644
Hackberry	22,892.506			11,216.826
	25,035.492			12,266.833
	75,106.482			36,800.501
Harris	25,116.273			11,556.632
	27,467.430			12,638.452
	82,402.290			37,915.360
Beazley	26,615.157			10,813.677
	28,599.651			11,825.951
	85,798.960			35,477.860
Canal	28,528.760			8,262.985
	31,342.461			9,036.490
	94,027.390			27,109.475
Station 22	38,659.616			8,200.355
	31,331.529			8,968.000
	93,994.590			26,904.000
M. P	29,097.040			8,449.899
	31,820.817			9,240.902
	95,462.455			27,722.711

Triangulation stations, beacons, harbor lines, etc., Galveston Bay, Texas, etc.—Continued.

Station.	North.	South.	East.	West.
Morgan Point	29,070.116			8,896.619
	31,791.390			9,729.439
	95,374.174			29,188.322
Atkinson	29,246.995			7,315.182
	31,984.823			7,675.169
	95,954.488			23,025.510
Mesquite Knoll	26,515.784			3,360.169
	28.997.960			3,674.717
	86,993.860			11,023.926
South Cedar	28,633.784			4,552.031
	31,314.223			4,978.151
	93,942.674			14,934.453
North Cedar	28,721.267			4,577.634
	31,409.891			5,006.150
	94,229.674			15,018.450
Allen	29,773.820			4,039.339
	32,560.977			4,417.464
	97,682.933			13,252.396
Midway	30,968.586			5,777.504
	33,867.581			6,318.342
	101,602.750			18,955.026
Dr. Smith	31,265.497			7,979.548
	34,192.283			8,726.520
	102,576.855			26,179.563
Tabb	31,534.000			9,557.110
	34,485.928			10,451.760
	103,457.785			31,355.280
Hog	30,522.552			8,101.230
	33,379.769			8,859.594
	100,139.309			26,578.785
Nav. 2	30,022.130			8,970.909
	32,832.526			9,810.682
	98,497.590			29,432.047
Nav. 3	30,147.573			9,076.747
	32,969.717			9,926.430
	98,909.720			29,779.294
Spillman 1	30,765.019			9,975.628
	33.644.961			10,909.453
	100,934.881			32,728.363
Spillman 2	30,223.869			10,932.747
	33,053.145			11,956.170
	99,159.454			35,868.512
2 S. J.	29,314.100			11,441.748
	32,058.220			12,512.821
	96,174.660			37,538.465
Daragon	29,615.680			12,632.919
	32,387.400			13,801.187
	97,162.200			41,403.571
Small	31,101.166			12,884.088
	34,012.574			14,090.178
	102,037.741			42,270.543
Strang	31,613.032			13,489.799
	34,572.349			14,752.588
	103,717.064			44,257.765
Thompson	31,894.636			15,360.292
	34,880.322			16,798.197
	104,640.986			50,394.558
Duck	32,312.883			11,015.276
	35,370.524			12,046.425
	106,111.589			36,139.283
Jennings	31.578.173			12,210.926
	34,534.230			13,354.000
	103,602.696			40,062.000
Grassy Point	32,268,498			12,486.339
	35,289.171			13,655.195
	105,867.536			40,965.585
McKee	33,346.784			12,099.725
	36,468.408			13,232.390
	109,405.239			39,697.174
Nav. 4	34,462.199			12,773.459
	37,688.234			13,969.194
	113,064.713			41,907.582
Davis	35,153.183			12,918.086
	38,443.903			14,127.360
	115,331.728			42,382.087
Badger	34,322,368			13,317.999
	37,535.310			14,564.704
	112,605.932			43,694.121
Marsh	34,712.168			13,884.721
	37,961.600			15,184.482
	113,884.803			45,553.452

Triangulation stations, beacons, harbor lines, etc., Galveston Bay, Texas, etc.—Continued.

Station.	North.	South.	East.	West.
Goat	35,430.378			14,198.926
	38,747.045			15,528.100
	116,241.149			46,584.301
Barnes	34,691.324			15,029.430
	37,938.808			16,436.347
	113,816.439			49,309.045
Upper Crack	35,410.763			15,612.449
	38,725.600			17,073.941
	116,176.791			51,221.833
Wooster	36,115.685			15,069.123
	39,496.500			16,479.756
	118,489.509			49,439.272
Peggy	35,878.547			16.324.192
	39,237.162			17,852.312
	117,711.490			35,556.950
Crystal	36,695.333			16,361.563
	40,130.407			17,893.170
	120,391.246			53,679.518
Burnett	37,943.893			15,739.430
	41,495.855			17,212.387
	124,487.564			51,637.166
Bluff	38,623.340			14,352.198
	42,238.903			15,695.646
	126,716.705			47,086.945
Tory Hill*	38,503.441			17,322.532
	42,107.786			18,944.109
	126,323.372			56,832.337
Hog Island	39,160.152			17,660.733
	42,825.970			19,313.969
	128,477.928			57,941.906
Lost	40,753.833			18,963.427
	44,568.826			20,738.608
	133,706.492			62,215.828
Fuller	37,776.982			18,834.333
	41,313.324			20,597.431
	123,939.973			61,792.300
Battlefield	36,963.608			18,725.864
	40,423.805			20,478.806
	121,271.452			61,436.422
Santa Anna	36,903.830			17,650.461
	40,358.426			19,302.733
	121,075.278			57,908.200
Thayer	31,811.482			20,300.387
	34,789.384			22,200.697
	104,368.149			66,602.092
Reef 3	6,886.215		16,487.078	
	7,530.838		18,030.456	
	22,592.515		54,091.350	
Reef 2	6,846.236		16,582.444	
	7,487.119		18,134.783	
	22,461.357		54,404.225	
Hannas Reef T. G	3,829.121		18,129.405	
	4,187.568		19,826.511	
	12,562.705		59,479.534	
Cren	1,013.597		16,754.978	
	1,108.481		18,328.422	
	3,325.442		54,970.278	
Parrs Grove	1,028.917		20,076.904	
	1,125.235		21,956.318	
	3,375.705		65,868.954	
Shaw	4,035.094		25,698.794	
	4,412.822		•28,104.477	
	13,233.466		84,313.442	
Cox	9,333.754		28,985.464	
	10,207.493		31,698.817	
	30,622.482		95,096.478	
Marsh Point	12,562.712		31,736.112	
	13,738.718		34,707.032	
	41,216.160		104,121.108	
Rollover T. G	12,137.600		36,888.229	
	13,273.806		40,341.364	
	39,821.431		121,024.122	
Rollover	9,399.589		37,418.726	
	10,279.492		40,921.430	
	30,838.482		122,764.576	
Muscle Point	12,934.063		39,455.774	
	14,144.831		43,149.267	
	42,434.500		129,447.797	
Midway	12,601.825		39,737.446	
	13,781.331		43,457.300	
	41,343.990		130,371.891	

Triangulation stations, beacons, harbor lines, etc., Galveston Bay, Texas, etc.—Continued.

Stations.	North.	South.	East.	West.
High Island Hotel	15,333.934		48,608.299	
	16,769.355		53,158.572	
	50,308.070		159,475.731	
High Island No. 2	16,234.532		49,213.401	
	17,754.261		53,820.530	
	53,262.790		161,461.635	
N. W. Bend	17,701.974		46,166.680	
	19,359.071		50,488.283	
	58,077.213		151,465.174	
E. Bay Bayou	16,409.388		44,564.874	
	17,945.485		48,736.630	
	53,836.456		146,209.899	
Jackson	15,360.644		41,346.180	
	16,798.565		45,216.635	
	50,395.701		135,649.906	
Frozen Point	13,511.175		35,985.069	
	14,775.966		39,353.657	
	44,327.908		118,060.978	
Robinsons Bayou	17,773.296		31,785.900	
	19,437.071		34,761.400	
	58,311.216		104,284.221	
Rip	15,009.595		26,652.439	
	16,414.656		29,147.396	
	49,243.977		87,442.204	
Stevenson Point	14,201.376		22,463.735	
	15,530.770		24,566.587	
	46,592.333		73,699.763	
Long Grove	13,243.141		18,509.299	
	14,482.843		20,241.972	
	43,448.530		60,725.916	
Smiths Point	11,902.361		12,473.687	
	13,016.550		13,641.358	
	39,049.657		40,924.075	
Smith	14,430.525		10,080.032	
	15,781.378		11,023.630	
	47,344.141		33,070.900	
Vingt 'Une	14,886.745		11,096.815	
	16,280.307		12,135.595	
	48,840.931		36,406.790	
Lone Oak	21,475.328		17,187.239	
	23,485.648		18,796.151	
	70,456.967		56,388.154	
Mouth Bayou beacon	25,583.241		18,808.160	
	27,978.110		20,568.805	
	83,934.346		61,706.428	
Double Bayou	29,065.686		19,122.304	
	31,786.551		20,912.357	
	95,359.666		62,737.085	
Round Point	35,088.247		19,284.723	
	38,372.886		21,089.980	
	115,118.673		63,269.970	
Round Point, T. G	35,159.306		18,795.470	
	38,450.601		20,554.464	
	115,351.809		61,663.400	
S. base Trinity	37,130.816		19.822.445	
	40,606.654		21,678.040	
	121,819.972		65,034.121	
N. base Trinity	38,640.936		20,077.170	
	42,258.155		21,956.611	
	126,774.473		65,869.833	
Anahuac	39,892.448		21,009.596	
	43,626.717		22,976.322	
	130,888.151		68,928.968	
Newt	43,747.525		22,785.262	
	47,842.769		24,918.212	
	143,528.316		74,754.638	
Turtle Bayou	44,859.149		21,298.564	
	49,058.449		23,292.337	
	147,175.355		69,877.016	
Wiggins	44,886.318		18,599.723	
	49,088.101		20,340.864	
	147,264.305		61,022.597	
Stimson	43,384.516		18,010.539	
	47,445.780		19,696.520	
	142,337.353		59,089.567	
Mack	41,087.891		19,356.623	
	44,934.156		21,168.614	
	134,802.484		63,505.840	
Coleman	40,146.386		18,335.504	
	43,904.535		20,051.900	
	131,713.606		60,155.710	

Triangulation stations, beacons, harbor lines, etc., Galveston Bay, Texas, etc.—Continued.

Station.	North.	South.	East.	West.
Bulk	38,534.186	...	17,943.023	...
	42,141.407	...	19,622.687	...
	126,424.227	...	58,868.067	...
Trinity R. beacon	36,441.386	...	17,310.104	...
	39,852.691	...	18,930.517	...
	119,558.100	...	56,791.558	...
Dolph	40,925.122	...	15,935.304	...
	44,756.154	...	17,427.144	...
	134,268.481	...	52,281.433	...
Junction	42,872.446	...	16,016.062	...
	46,885.763	...	17,515.342	...
	140,657.314	...	52,546.024	...
Lawrence Cove	39,141.718	...	10,785.323	...
	42,805.821	...	11,794.945	...
	128,417.463	...	35,384.837	...
Browns Beach	37,462.686	...	7,735.761	...
	40,037.017	...	8,459.911	...
	120,111.052	...	25,379.736	...
Barrows House	35,829.176	...	6,112.228	...
	39,183.171	...	6,684.400	...
	117,549.539	...	20,053.152	...
Fisher	33,867.063	...	4,437.668	...
	37,037.384	...	4,853.082	...
	111,112.174	...	14,559.247	...
Fishers reef	26,440.927	...	5,723.173	...
	28,916.086	...	6,258.923	...
	86,748.260	...	18,776.771	...
Umbrella Point	29,103.334	...	2,688.808	...
	31,827.728	...	2,885.822	...
	95,483.177	...	8,657.488	...
Cedar Point	27,809.667	...	1,639.935	...
	30,412.951	...	1,793.450	...
	91,238.872	...	5,380.852	...

HARBOR LINE, BOLIVAR POINT.

Station.	North.	South.	East.	West.
A (Old Beacon Alpha)		6,034.631	14,759.296	...
		6,599.538	16,140.929	...
		19,798.618	48,422.788	...
B		6,812.101	12,834.990	...
		7,449.786	14,036.492	...
		22,349.361	42,109.485	...
C		6,568.092	11,451.603	...
		7,182.845	12,523.591	...
		21,548.537	37,570.776	...
D		6,252.729	10.949.476	...
		6,838.054	11,974.465	...
		20,514.161	35,923.398	...
E		5,593.639	10,553.003	...
		6,117.263	11,540.875	...
		18,351.790	34,622.625	...
F		4,679.101	10,551.793	...
		5,117.114	11,539.556	...
		15,351.343	34,618.672	...
G		2,282.076	11,014.985	...
		2,496.394	12,046.111	...
		7,489.183	36,138.341	...

HARBOR LINE, GALVESTON ISLAND.

Station.	North.	South.	East.	West.
A (new)	...	9,162.918	12,045.579	...
		10,020.663	13,173.176	...
		30,061.992	39,519.536	...
A¹	...	9,300.126	11,871.913	...
		10,170.719	12,983.258	...
		30,512.161	38,949.776	...
B	...	9,680.441	11,661.279	...
		10,586.634	12,752.903	...
		31,759.905	38,258.708	...
C	...	9,877.273	11,589.640	...
		10,801.890	12,674.555	...
		32,405.670	38,023.666	...
D	...	10,753.461	11,312.169	...
		11,760.100	12,370.111	...
		35,280.300	37,113.333	...

Triangulation stations, beacons, harbor lines, etc., Galveston Bay, Texas, etc.—Continued.

HARBOR LINE, GALVESTON ISLAND—Continued.

Station.	North.	South.	East.	West.
E	...	11,245.792	10,925.713	...
		12,298.522	11,948.478	...
		36,895.567	35,845.437	...
F	...	11,301.925	10,877.424	...
		12,359.821	11,895.666	...
		37,079.466	35,687.000	...
G^1	...	11,594.681	10,564.244	...
		12,680.067	11,553.170	...
		38,040.210	34,659.510	...
G^2	...	11,877.882	10,154.630	...
		12,989.779	11,106.213	...
		38,969.342	33,315.641	...
H^1	...	12,041.346	9,871.307	...
		13,168.545	10,795.364	...
		39,505.636	32,386.097	...
H^2	...	12,108.974	9,728.609	...
		13,242.505	10,639.311	...
		39,727.514	31,917.934	...
I^1	...	12,253.756	9,152.080	...
		13,400.843	10,008.814	...
		40,202.528	30,026.444	...
I^2	...	12,266.583	8,893.990	...
		13,414.867	9,726.562	...
		40,244.611	29,179.689	...
K	...	12,261.850	8,193.131	...
		13,409.691	8,960.100	...
		40,229.083	26,880.300	...
L	...	12,211.860	7,454.515	...
		13,355.022	8,152.332	...
		40,065.073	24,457.000	...
M	...	11,941.140	6,343.996	...
		13,058.961	6,937.868	...
		39,176.882	20,813.603	...
N	...	12,794.421	3,495.398	...
		13,992.116	3,822.606	...
		41,976.349	11,467.820	...
O	...	14,105.352	2,417.884	...
		15,425.765	2,644,176	...
		46,277.299	7,932.527	...

HARBOR LINE, PELICAN ISLAND.

A (old red beacon)	...	10,560.504	11,029.876	...
		11,549.080	12,073.328	...
		34,647.238	36,220.000	...
B	...	11,110.800	10,594.895	...
		12,150.891	11,586.693	...
		36,452.672	34,760.080	...
C	...	11,078.045	9,295.718	...
		12,115.071	10,165.900	...
		36,345.210	30,497.700	...
D	...	9,010.710	5,423.454	...
		9,854.210	5,931.231	...
		29,562.632	17,793.700	...
E	...	8,148.025	5,423.531	...
		8,910.775	5,931.232	...
		26,732.327	17,793.696	...
F	...	6,627.086	6,233.711	...
		7,247.453	6,817.255	...
		21,742.360	20,451.774	...
G	...	6,867.906	7,934.029	...
		7,510.810	8,676.738	...
		22,532.444	26,030.215	...
H	...	8,854.971	11,532.658	...
		9,683.900	12,612.238	...
		29,051.699	37,836.714	...
I	...	9,622.421	11,319.680	...
		10,523.180	12,879.820	...
		31,569.550	37,137.966	...
K	...	9,714.776	11,297.715	...
		10,624.174	12,355.074	...
		31,872.528	37,065.222	...
A (old red beacon)	...	10,560.504	11,029.876	...
		11,549.080	12,073.328	...
		34,647.238	36,220.000	...

Triangulation stations, beacons, harbor lines, etc., Galveston Bay, Texas, etc.—Continued.

HARBOR LINE, VIRGINIA POINT.

Station.	North.	South.	East.	West.
A	....	12,700.342	....	226.345
		13,889.250	....	247.533
		41,667.690	....	742.600
B	....	11,858.446	501.583	....
		12,968.525	548.536	....
		38,905.580	1,645.609	....
C	....	6,034.591	502.484	....
		6,599.494	549.522	....
		19,798.482	1,648.566	....
D	....	4,921.836	320.368	....
		5,382.574	350.357	....
		16,147.725	1,051.073	....
E	....	4,220.765	320.887	....
		4,615.874	350.925	....
		13,847.624	1,052.776	....
F	....	3,062.448	663.798	....
		3,349.129	725.937	....
		10,047.384	2,177.810	....
G	....	2,158.755	520.870	....
		2,360.838	569.082	....
		7,082.513	1,707.247	....

HARBOR LINES, SAN JACINTO BAY (LAPORTE).

Station.	North.	South.	East.	West.
1	29,236.625	....	....	8,467.496
	31,973.485	....	....	9,260.130
	95,920.466	....	....	27,780.452
2	29,396.500	....	....	8,600.500
	32,148.325	....	....	9,405.600
	96,445.000	....	....	28,216.800
3	29,439.749	....	....	8,833.750
	32,195.630	....	....	9,660.680
	96,586.888	....	....	28,982.054
4	29,116.595	....	....	10,508.498
	31,842.219	....	....	11,492.262
	95,526.666	....	....	34,476.635
5	29,289.255	....	....	11,325.348
	32,031.044	....	....	12,385.524
	96,093.133	....	....	37,156.663

REPORT OF MR. E. M. HARTRICK, ASSISTANT ENGINEER.

GALVESTON, TEX., *July 8, 1902.*

CAPTAIN: I have the honor to submit the following report of operations for improving harbor at Galveston, Tex., during the fiscal year ending June 30, 1902.

JETTIES.

No work was done on either north or south jetty on account of lack of an appropriation.

At the beginning of the fiscal year the jetties were in apparently the same condition as when reported on by the Board of Engineers, House Doc. No. 134, Fifty-sixth Congress, second session.

The steam tug *Anna* was put out of commission July 31, 1901, for want of funds, and has been laid up at Morgans Point since that date.

The dredge *Gen. C. B. Comstock*, leaking and showing signs of weakness, was hauled out for general repairs November 2, 1901. These repairs were the completing of those deemed necessary after the hurricane of September 8, 1900, but the urgent demand for the dredge was so great immediately after the storm that time sufficient to complete the repairs could not be allowed until certain channels had been opened up and shoals removed. The dredge returned to work after a thorough overhauling and strengthening of hull January 15, 1902. On February 9, 1902, the dredge was turned over to Montgomery (Ala.) district, and returned to Galveston June 15, 1902.

[Dredging operations of U. S. dredge *Gen. C. B. Comstock*, G. M. Prendergast, master.]

During the first half month of the year the dredge was laid up for minor repairs to machinery.

For the next two months, from July 15 to September 15, inclusive, in the interest of commerce and on account of the Galveston Wharf Company's dredging plant having been destroyed by fire, the dredge was operated by the Galveston Wharf Company on the channel in front of their wharves and in the slips. (A tabulated statement of this dredging and the cost thereof accompanies this report.)

For the next three and two-thirds months the dredge was laid up for general repairs to hull and machinery, additional to the temporary repairs of November, 1900, which were made to fit the dredge for work on the inner bar, where it was urgently needed. The repairs were made necessary by the injuries sustained during the severe hurricane of September 8, 1900, at which time the dredge was stranded on Pelican Flats. (See Annual Report of the Chief of Engineers United States Army for 1901, p. 1926.)

During the next month, from January 7 to February 8, 1902, the dredge was employed on the outer-bar channel when weather permitted, and at other times on channel over inner bar.

February 9, 1902, the dredge was transferred to the Montgomery, Ala., district, and on February 13 sailed for Pensacola, Fla., at which she was operated under the direction of First Lieut. R. R. Raymond, Corps of Engineers, United States Army. June 15, 1902, the dredge was transferred back to the Galveston, Tex., District, at Galveston, Tex., and for the remainder of the fiscal year was employed on the outer-bar channel.

The total amount of material removed in Galveston Harbor was 181,485 cubic yards, of which 102,106 cubic yards was from channel in front of wharves, and of which 86,371 cubic yards was soft mud or slush and 15,735 cubic yards was fine sand, and 79,379 cubic yards was from outer and inner bar channels,37,719 cubic yards being sand and 16,269 cubic yards being composed of sand, fine shell, and mud from outer-bar channel, and 25,391 cubic yards of sand, fine shell, and soft mud and occasional lumps of clay from channel over inner bar.

The operating cost per cubic yard dredged from channel in front of wharves was 6.18 cents.

The total cost per cubic yard dredged from channel in front of wharves was 9.11 cents.

The operating cost per cubic yard dredged from channels over outer and inner bars was 10.32 cents.

Details of work done, distribution of time, and cost of dredging are herewith forwarded in tabulated form.

Resume of work done by United States dredge Gen. C. B. Comstock during the fiscal year ending June 30, 1902.

ON GALVESTON CHANNEL IN FRONT OF WHARVES.

	Hours.	Minutes.
Effective working time	512	23
Delays for—		
Bad weather		
Repairs		
Other causes	77	12
Idle on account of Sundays and holidays	180	00
Total time made	769	35

	Distribution of working time.		
	Hours.	Minutes.	Per cent.
Anchorage to cut	3	2	0.5
Pumping	296	53	58
Cut to dump	94	36	18.5
Dumping	12	10	2
Dump to cut	70	7	14
Dump to anchorage	30	24	6
Time lost turning	5	11	1
Effective working time	512	23	100

Number of loads dredged		189
Average output per hour	cubic yards..	344
Average amount dredged per minute in—		
Fine sand	do....	5.45
Soft mud	do....	5.78

COST OF DREDGING.

	Amount.	Cost per yard.
		Cents.
Wages	$3,030.67	2.97
Subsistence	841.01	.82
Fuel	1,459.04	1.43
Oils, waste, packing, etc	179.32	.18
Miscellaneous supplies	34.08	.03
Ordinary maintenance	297.59	.29
Contingent expense	19.25	.02
Operating cost	5,860.96	5.74
Rental of dredge	3,050.00	....
Total	8,910.96	8.72

ON OUTER AND INNER BAR CHANNELS.

	Hours.	Minutes.
Effective working time	276	49
Delays for—		
Bad weather	121	11
Repairs	1,275	5
Other causes	99	30
Idle on account of Sundays and holidays	264	00
Total time made	2,036	35

	Distribution of working time.		
	Hours.	Minutes.	Per cent.
Anchorage to cut	22	35	8
Pumping	169	02	61
Cut to dump	29	59	11
Dumping	11	57	4.5
Dump to cut	22	00	8
Dump to anchorage	17	27	6
Time lost turning	3	49	1.5
Effective working time	276	49	100

Number of loads dredged		147
Average output per hour dredging	cubic yards..	470
Average amount dredged per minute in—		
Sand	do....	7.48
Mud and fine shell	do....	8.16

COST OF DREDGING.

	Amount.	Cost per yard.
		Cents.
Wages	$3,309.47	4.17
Subsistence	1,692.81	2.13
Fuel	1,645.65	2.07
Oils, waste, packing, etc	254.61	.33
Miscellaneous supplies	415.90	.52
Ordinary maintenance	969.32	1.22
Contingent expense	227.44	.29
Operating cost	8,515.20	10.73
Extraordinary repairs occasioned by the severe hurricane of September 8, 1900	27,081.93	....
Total	35,597.13	....

BAR SURVEY.

Only a few surveys were made during the year on account of the survey boat *Anna* being laid up. The pilots, with their usual courtesy, tendered their boat *Galveston* when the steam launch *Helen*, of Ship Channel, was not available for surveys on outer and inner bars.

The survey of June 11 and 12 on the outer bar shows a wide navigable channel between the 24-foot curves with a mid-channel depth of 26 feet, except in one place between entrance inner black gas buoy and inner black gas buoy on the south and No. 4 red buoy on the north. In this area there were several lumps with less than 26 feet of water over them. There is also a tendency for the 24-foot curve on the south and west bank to push east across the channel. Taking everything into consideration, unrepaired, leaky jetties, and no work on the outer bar channel by dredging for months, it is a good showing for maintenance by jetty without aid by dredging. On the return of the dredge from Pensacola she was put to work June 19 on the outer bar channel to remove the lumps and shoals. After working from June 19 to June 24, and removing 13,397 cubic yards of material, there was reported a good 26-foot navigable channel. The dredge was then laid up to have an oil-burning plant installed.

The survey of June 13 of the inner bar shows a navigable channel of 26½ feet, with a channel width of 400 feet between the 24-foot curves. It is proposed to widen the channel on the inner bar to 600 feet as soon as the dredge has been converted into an oil burner.

STORMS.

There were two storms during the fiscal year accompanied with more or less high water; one on July 9 and 10, 1901, and one on June 26 and 27, 1902. The water backed up on the beach to an average height of 5½ feet and 4½ feet, respectively, and on the bay a maximum observed was 4.6 and 4.2, respectively. The storm of July, 1901, the maximum velocity of the wind was 40 miles an hour from the east, and a heavy swell from the southeast; that of June, 1902, the maximum velocity was 49 miles an hour from the southeast, with gusts of 60 miles an hour and a heavy swell on the Gulf of Mexico from the south.

Very respectfully, your obedient servant

E. M. Hartrick,
Assistant Engineer.

Capt. C. S. Riché, *Corps of Engineers.*

U 2.

IMPROVEMENT OF GALVESTON CHANNEL, TEXAS.

No work has been done up to the close of the fiscal year, except to submit a project for the expenditure of the amount appropriated by the river and harbor act approved June 13, 1902.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902	$100,000.00
July 1, 1902, balance unexpended	100,000.00
Amount (estimated) required for completion of existing project	1,485,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	200,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

ABSTRACT OF APPROPRIATIONS MADE BY CONGRESS FOR IMPROVING GALVESTON CHANNEL.

By act of June 13, 1902	$100,000

U 3.

IMPROVEMENT OF CHANNEL FROM GALVESTON HARBOR TO TEXAS CITY, TEXAS.

* * * * * * *

The dredging of this channel is being done under contract entered into with the Drake & Stratton Company, of New York, N. Y., for $250,000, $100,000 to be paid when the channel has been deepened to a depth of 21 feet, and the remainder of the price when the whole work has been completed in a manner satisfactory to the Secretary of War.

The river and harbor act approved June 13, 1902, provides for the amending of this contract as follows:

> The Secretary of War is hereby authorized and directed, with the consent of the contractors now engaged in said work, or any contractors who may hereafter undertake the same, to modify the contract heretofore entered into for the performance of said work so that payments of five per centum of the whole contract price shall be made from time to time to said contractors for each one thousand linear feet along the length of said channel, whenever it shall satisfactorily appear to the Secretary of War that a depth of twenty-five feet and a width of one hundred feet at the bottom are obtained, until the sum of two hundred thousand dollars has been paid, after which no payments shall be made until the whole channel has been completed to the required width and depth, at which time the balance of the contract price shall be paid. And before such modification shall take effect the contractors for said work shall give bond to the United States, with sufficient surety or sureties, to be approved by the Secretary of War, conditioned upon the complete and faithful performance of said work as originally contracted for within two years from the date of said modification, in the sum of one hundred thousand dollars.

Active operations were continued during the year.

* * * * * * *

A detailed account of the work done will be found in the report of Mr. E. M. Hartrick, assistant engineer, forwarded herewith, to which attention is invited.

Money statement.

DEPOSIT OF CONTRACTORS.

July 1, 1901, balance unexpended	$3,364.82
June 30, 1902, amount expended during fiscal year	316.67
July 1, 1902, balance unexpended	3,048.15
July 1, 1902, outstanding liabilities	16.67
July 1, 1902, balance available	3,031.48

GENERAL IMPROVEMENT.

July 1, 1901, balance unexpended	$250,000.00
July 1, 1902, balance unexpended	250,000.00
July 1, 1902, amount covered by uncompleted contracts	250,000.00

ABSTRACT OF APPROPRIATIONS MADE BY CONGRESS FOR DEEPENING THE CHANNEL FROM GALVESTON HARBOR TO TEXAS CITY, TEX.

By act of March 3, 1899	$250,000.00

CONTRACT IN FORCE DURING FISCAL YEAR FOR DEEPENING THE CHANNEL FROM GALVESTON HARBOR TO TEXAS CITY, TEX.

Contractor: The Drake & Stratton Company, New York, N. Y.
Character of work: Dredging.
Rate: $250,000.
Date of approval: January 22, 1900.
Date of beginning work: June 30, 1900.
Date of expiration: Contract time waived.

COMMERCIAL STATISTICS.

No commercial statistics for the fiscal year ending June 30, 1902, could be obtained. Inquiries by letter were made, but no replies have been received up to June 30, 1902.

REPORT OF MR. E. M. HARTRICK, ASSISTANT ENGINEER.

GALVESTON, TEX., *July 1, 1902.*

CAPTAIN: I have the honor to submit the following report of operations on the improvement of channel from Galveston Harbor to Texas City, Tex., during the fiscal year ending June 30, 1902:

CONDITION OF THE WORK.

At the beginning of the fiscal year the channel had been excavated to an average depth of 17 feet and 120 feet wide at bottom for a distance of 14,350 feet. At the end of the fiscal year the channel averaged from 17½ to 23 feet, 120 feet wide, between Texas City and Galveston Harbor, except between station 8 and 12+500, where there was a refill, giving a channel depth of 13½ feet 130 feet wide.

OPERATIONS DURING THE YEAR.

Nine hundred and sixty-seven thousand one hundred cubic yards of material were removed, of which 829,735 cubic yards were from prescribed cross section. Total removed to date under present contract, 1,782,160 cubic yards, of which 1,556,715 cubic yards were from prescribed cross section.

Total movement of dredge was 18,750 feet, giving an average channel depth between station 0 and station 8 (8,000 feet) of 23 feet, 110 feet wide at bottom. From station 8 to 12+500 the channel is only 13½ feet deep on account of storm of July 9 and 10, 1901, washing the spoil deposited on the south side of cut into the channel. From station 12+500 to station 25 the channel is from 17½ to 21 feet deep, thence toward Galveston Harbor deepening gradually to 25 feet, the contract depth. There remains to be excavated about 700,000 cubic yards to complete contract, but this does not include extra material to be removed on account of filling up of channel before acceptance of work.

The dredge worked 4,952 hours out of a possible 7,512, or 15.82 hours per 24 hours.

STORMS.

Two storms occurred during the year, one July 9 and 10, 1901, and one June 26 and 27, 1902. The wind reached a maximum velocity of 40 and 49 miles an hour, accompanied by a tide of 5½ and 4½ feet, respectively.

The storm of July, 1901, washed back material into channel deposited in ends of Texas City piers, overtopped the spoil bank, and washed back most of the material deposited above mean low tide. The section of channels thus filled had been excavated to an average depth of 17½ feet; after the storm it was 13½ feet, a refill of 4 feet in a 9-foot cut.

Very respectfully, your obedient servant,

E. M. HARTRICK,
Assistant Engineer.

Capt. C. S. RICHÉ,
Corps of Engineers.

U 4.

IMPROVEMENT OF GALVESTON SHIP CHANNEL AND BUFFALO BAYOU, TEXAS.

The object of this improvement is to provide the city of Houston with a waterway to Galveston and the Gulf of Mexico, having a channel depth of 25 feet. (Annual Report Chief of Engineers for 1898, p. 1516 et seq.)

This work now embraces two separate improvements, i. e., improving ship channel in Galveston Bay, Texas (Annual Report Chief of Engineers for 1892, p. 1536 et seq.), and improving Buffalo Bayou, Texas (Annual Report Chief of Engineers for 1891, p. 1344 et seq.)

* * * * * * *

The available funds for improving ship channel in Galveston Bay, Texas, and improving Buffalo Bayou, Texas, are to be used in connection with appropriation for improving Galveston Ship Channel and Buffalo Bayou, Texas, in dredging a channel 70 feet wide, 17 feet deep, with side slopes about 1 on 2, from deep water in Galveston Harbor, through Galveston Bay and Morgans Cut (division 1), constructing pile and brush dike from Morgans Cut to Redfish Bar, and surveys, superintendence, and contingencies that may be necessary, the sum of $25,000 being reserved for expenditure for expenses of administration, surveys, and maintenance above division 1 (through San Jacinto Bay to Houston, Tex.).

At the beginning of the fiscal year active operations were being carried on by the contractors, and the condition of the work was as follows:

Dike piling was at station 23+330, a distance of 21,000 feet from Morgans Canal. Brush filling between pile dike was at station 16+300, a distance of 14,100 feet from Morgans Canal. Dike and channel had been completed to station 13+5, a total distance of 11,300 feet from Morgans Canal.

During the fiscal year the following work was done:

DIVISION 1—SECOND SUBDIVISION.

Nineteen thousand six hundred and sixty-one piles were driven, aggregating 455,699.9 linear feet. Dike piling advanced from station 23+330 to station 62+450, end of pile dike, a total distance of 39,120 feet. Brush filling between dike piling advanced from station 16+300 to station 62+450, end of pile dike, a total distance of 46,150 feet.

One million three hundred and one thousand nine hundred and twenty-eight and ninety one-hundredths cubic yards of material were excavated, as per prescribed cross section, and 163,190.10 cubic yards below prescribed cross section, from station 12 to 62+5.

The dike and channel of Division 1, second subdivision, is complete, having a navigable channel depth of from 17 to 20 feet at mean low tide, with a bottom width of 70 feet. Total amount of material dredged in this division was 1,592,496.71 cubic yards, as per prescribed cross section, and 197,309.70 cubic yards below prescribed cross section.

Total number of piles in dike, 30,314, aggregating 673,654.7 linear feet of piling. The total length of dike, including a 250-foot end protection, is 60,500 feet.

The dike which is building is a temporary structure and will not be permanent. It is a submerged sand fence constructed of piles and brush, behind which the excavated material is deposited. If the full section of the channel (25 feet deep by 150 feet wide at bottom) could be made at once, enough material could be obtained to protect the dike piling from the teredo and from damage from all but storms of great severity. It is hoped, however, that the present structure will remain in fair condition for about two years, by which time contracts for additional dredging can be in force. Meanwhile the existence of the pile and brush dike, by keeping the dredged material from being washed back into the channel, will retard its being filled in, while in the absence of any dike the channel would be liable to fill quite rapidly during ordinary storms. The dike has already stood two severe storms, one in July, 1901, and the other in June, 1902. On both occasions it was entirely covered with water, with heavy seas breaking over it. It stood these strains successfully and greatly protected the dredged channel.

DIVISION 1—FIRST SUBDIVISION.

One million one hundred and forty-seven thousand six hundred and sixty and twenty-seven one-hundredths cubic yards of material were excavated as per prescribed cross section, and 159,955.49 cubic yards below prescribed cross section from stations 0+0 to 1+5 and 17+1 to 57+0.

Amount expended on these improvements to June 30, 1902, $1,302,642.25.

All expenses of superintendence and inspection, including surveys for estimates, on this work under the contract of Charles Clarke & Co. have been charged to the contractor since November 1, 1901. It is expected that the contract will be completed by August 31, 1902.

Project for expenditure of amount appropriated by river and harbor act approved June 13, 1902, has been submitted.

Money statements.

GALVESTON SHIP CHANNEL AND BUFFALO BAYOU, TEXAS.

July 1, 1901, balance unexpended	$300,000.00
Amount appropriated by river and harbor act approved June 13, 1902	300,000.00
	600,000.00
June 30, 1902, amount expended during fiscal year	224,875.40
July 1, 1902, balance unexpended	375,124.60
July 1, 1902, outstanding liabilities	31,805.61
July 1, 1902, balance available	343,318.99
July 1, 1902, amount covered by uncompleted contracts	23,859.95
Amount (estimated) required for completion of existing project	3,400,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	700,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

BUFFALO BAYOU.

July 1, 1901, balance unexpended	$5,852.10
June 30, 1902, amount expended during fiscal year	5,852.10

ABSTRACT OF APPROPRIATIONS MADE BY CONGRESS FOR IMPROVING GALVESTON SHIP CHANNEL AND BUFFALO BAYOU, TEXAS.

By act of—	
March 3, 1899	$300,000
June 13, 1902	300,000
Total	600,000

ABSTRACT OF APPROPRIATIONS MADE BY CONGRESS FOR IMPROVING SHIP CHANNEL IN GALVESTON BAY, TEXAS.

By act of—	
June 10, 1872	$10,000.00
June 23, 1874	10,000.00
March 3, 1875	35,200.00
August 14, 1876	72,000.00
June 18, 1878	75,000.00
March 3, 1879	80,000.00
June 14, 1880	50,000.00
March 3, 1881	50,000.00
August 2, 1882	$94,500.00
August 11, 1888	100,000.00
September 19, 1890	132,316.85
July 13, 1893	40,000.00
August 18, 1894	50,000.00
June 3, 1896	50,000.00
Total	849,016.85

ABSTRACT OF APPROPRIATIONS MADE BY CONGRESS FOR IMPROVING BUFFALO BAYOU, TEXAS.

By act of—	
March 3, 1881	$25,000
August 2, 1882	50,000
July 2, 1884	25,000
August 5, 1886	18,750
August 11, 1888	25,000
September 19, 1890	25,000
July 13, 1892	$25,000
August 18, 1894	15,000
June 3, 1896	20,000
Total	228,750

CONTRACT IN FORCE DURING FISCAL YEAR FOR IMPROVING GALVESTON SHIP CHANNEL AND BUFFALO BAYOU, TEXAS.

Contractor: Charles Clarke & Co., Galveston, Tex.

Character of work: Dredging and constructing pile and brush dike.

Rates: Dredging, 6.98 cents per cubic yard; dike, 11½ cents per linear foot of piling required.

Date of approval: August 3, 1900.

Date of beginning work: December 4, 1900.

Date of expiration: Time limit waived.

COMMERCIAL STATISTICS.

The only commercial statistics that could be obtained for the fiscal year was the amounts carried by the Houston Direct Navigation Company, as follows:

Vessels using the bayou and ship channel, 26 (5 steam vessels and 21 barges); average length, 160 feet; average depth, 8 feet.

Amount and value of freight transported.

Articles.	Tons.	Approximate value.
Cotton (486,229 bales)	115,021.11	$20,938,992.00
Cotton products (meal and cake)	1,993	23,916.00
Coal	2,409	13,273.59
Lumber (ash and pine)	2,979	44,685.00
Bank sand	3,445	1,566.50
Reef shell	6,321.6	7,187.50
Walnut logs and lumber	222	4,440.00
San Jacinto sand	6,353	3,531.75
Bank clay	2,387	1,085.00
Total	141,130.86	21,038,677.34

For number of vessels and tonnage passing through Morgans Canal, see report on Operating and Care of Morgans Canal (Appendix U 5).

U 5.

OPERATION AND CARE OF MORGANS CANAL, TEXAS.

* * * * * * *

During the fiscal year bids for repairing the bulkhead of canal were solicited under poster and circular letter dated September 12, 1901 (twenty days' public notice), and were opened October 1, 1901. Only one bid was received, that of Moore & Sieber, of Texas City, Tex. Their bid was accepted and emergency contract entered into under date of November 7, 1901. The prices for the work covered by the contract are as follows:

Constructing bulkhead, complete, $6.05 per linear foot.

Removing worthless bulkhead, $1.33⅓ per linear foot.

Also bid for furnishing and erecting fence and gate posts for boundary fence to Government reservation were solicited under poster and circular letter, dated May 13, 1902 (ten days' public notice), and bids were opened on May 23, 1902. Two bids were received, and award made to the lowest bidder, Moore & Sieber, of Texas City, Tex., at the following prices:

Fence posts, delivered and put in place, 30 cents each.

Gate posts, delivered and put in place, 40 cents each.

The repair of the bulkhead of the canal was practically completed by the contractors during the fiscal year. There only remains to be done the bolting of the lower course of waling pieces to the guide piles, and the trimming of the tops of piles to grade.

Two hundred and forty-seven linear feet of old bulkhead were removed. Eighty-three guide piles, 73 on main line of bulkhead and 9 for shore and offset connections, were driven. Six hundred and fifty-three sheet piles were driven, 472 in main line of bulkhead and 181 in shore and offset connections. Two thousand six hundred and twelve linear feet of waling pieces placed and 22 fender piles driven. Contractors furnished and placed 100 fence posts and 4 gate posts on west side of canal, and 50 posts on east side of canal, for fence on boundary line of reservation.

The amount expended during the fiscal year was as follows:

James A. Black, salary twelve months, at $30 per month	$360.00
Notary fee to affidavit to contract for returns office	.25
Traveling expenses of assistant engineer inspecting work	3.00
Total	363.25

Money statement.

July 1, 1901, balance unexpended	$5,000.00
June 30, 1902, amount expended during fiscal year	363.25
July 1, 1902, balance unexpended	4,636.75
July 1, 1092, outstanding liabilities	65.00
July 1, 1902, balance available	4,571.75
July 1, 1902, amount covered by uncompleted contracts	4,500.00

ABSTRACT OF ALLOTMENTS MADE FOR OPERATING AND CARE OF MORGANS CANAL, TEXAS, PROVIDED FOR BY SECTION 4, ACT OF JULY 5, 1884.

December 2, 1896	$240	July 14, 1900	$360
July 16, 1897	360	June 11, 1901	5,000
July 1, 1898	360		
July 1, 1899	360	Total	6,680

CONTRACT IN FORCE DURING THE FISCAL YEAR FOR REPAIRING BULKHEAD AT MORGANS CANAL, TEXAS.

Contractor: Moore & Sieber, Texas City, Tex.

Character of work: Repairing bulkhead.

Rates: Constructing bulkhead complete, $6.05 per linear foot. Removing worthless bulkhead, $1.33⅓ per linear foot.

Date of approval: No date. Emergency contract.

Date of beginning work: May 6, 1902.

Date of expiration: August 25, 1902.

COMMERCIAL STATISTICS.

Number and tonnage of vessels passing through Morgans Canal during the fiscal year ending June 30, 1902, as reported by the watchman at the canal.

	Vessels engaged in carrying freight.	Tonnage (registered).	Vessels in the employ of the United States or its contractors.	Tonnage (registered).	Total number of vessels.	Total tonnage (registered).
Totals up and down	1,847	169,449.2	1,054	23,770	2,901	193,219.2

U 6.

IMPROVEMENT OF TRINITY RIVER, TEXAS.

No work has been done up to the close of the fiscal year, except to submit a project for expenditure of the amount appropriated by the river and harbor act approved June 13, 1902.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902	$125,000.00
July 1, 1902, balance unexpended	125,000.00
Amount (estimated) required for completion of existing project	3,875,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	275,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

ABSTRACT OF APPROPRIATIONS MADE BY CONGRESS FOR IMPROVING TRINITY RIVER, TEXAS.

By act of June 13, 1902	$125,000

U 7.

IMPROVEMENT OF THE BRAZOS RIVER BETWEEN VELASCO AND RICHMOND, WEST GALVESTON BAY CHANNEL, DOUBLE BAYOU, AND THE MOUTHS OF THE ADJACENT STREAMS.

* * * * * * *

The available funds at the end of the fiscal year for improving Brazos River, Texas, channel in West Galveston Bay, and Trinity River, Texas, are to be used in dredging and snagging at those points in connection with the present appropriation. The present appropriation is to be expended in designing, constructing, and operating a combined dredge and snag boat.

The object of this improvement is to obtain a navigable channel depth of from 4 to 6 feet across the bars at the mouths of most of the streams and bayous along the Texas coast. (See also House Doc. No. 446, Fifty-sixth Congress, first session, reprinted as pp. 2438–2453, Annual Report of the Chief of Engineers for 1900.)

The designing of the combined dredge and snag boat for work on this improvement has been in the hands of Capt. Mason M. Patrick and Capt. G. P. Howell, Corps of Engineers, United States Army, secretaries to the Mississippi River Commission, at St. Louis, Mo., and was done under their direction by Assistant Engineer Thomas Middleton.

Contracts for the various parts of the dredge had been entered into at the beginning of the fiscal year.

During the fiscal year all parts of the dredge were delivered, and same were installed in the hull of the dredge, steam connections made, and deck house has been constructed.

At the close of the fiscal year the dredge is practically complete, except electric-light wiring and necessary furnishing for cabin and outfit for operating the dredge. Orders have been placed for furnishings and outfit for operating dredge, and electric-light wiring is being installed. Steam has been gotten up in the boilers and various parts of the dredge given a preliminary steam test. It is expected that the dredge will be entirely completed by the last of July, 1902, and will be given final test and put in active operation.

Attention is invited to the saving resulting from the method adopted in building this dredge. By purchasing the hull and various parts of the machinery, etc., under separate contracts, and installing and completing the dredge by hired labor, competition was greatly increased, and the payment of profits to middlemen was avoided. Had the dredge been obtained complete under one contract, it is my opinion that her cost to the United States would have been in the neighborhood of $90,000, by reason of the lessened amount of competition possible. As it is, the dredge will be obtained for not over $65,000. In assembling a vessel of this character by hired labor there is, of course, great danger of increased expense, owing to the various parts not properly fitting together. The detailed designs prepared by Mr. Thomas Middleton, under the direction of Captain Patrick and Captain Howell, have been so complete and so accurate that there has been absolutely no trouble in assembling the plant, and needless expense of this character has been avoided. The assembling has been done under the immediate direction of Capt. William J. Lynch, the master of the boat, who holds licenses for both master and chief engineer, and who thus becomes thoroughly familiar with every detail of the vessel by the time she goes into service.

Project for the expenditure of the amount appropriated by river and harbor act approved June 13, 1902, submitted, but up to close of fiscal year had not been approved.

Amount expended on this improvement to June 30, 1902, $55,931.59.

A detailed account of the work during the fiscal year and description of the dredge will be found in the report of Mr. E. M. Hartrick, assistant engineer, forwarded herewith, to which attention is invited.

Money statement.

July 1, 1901, balance unexpended	$63,470.68
Amount appropriated by river and harbor act approved June 13, 1902	50,000.00
	113,470.68
June 30, 1902, amount expended during fiscal year	54,402.27
July 1, 1902, balance unexpended	59,068.41
July 1, 1902, outstanding liabilities	6,899.57
July 1, 1902, balance available	52,168.84
Amount (estimated) required for completion of existing project	130,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	100,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

ABSTRACT OF APPROPRIATIONS MADE BY CONGRESS FOR THE IMPROVEMENT OF THE BRAZOS RIVER BETWEEN VELASCO AND RICHMOND, WEST GALVESTON BAY CHANNEL, DOUBLE BAYOU, AND THE MOUTHS OF THE ADJACENT STREAMS.

By act of March 3, 1899	$65,000
By act of June 13, 1902	50,000
Total	115,000

Contracts in force during fiscal year for building the hull and machinery of a self-propelling hydraulic dredge.

Contractor.	Character of work.	Rate.	Date of approval.	Date of beginning work.	Date of expiration.
Moore & Sieber, Texas City, Tex.	Hull	$10,930.00	1901. Apr. 7	1901. May 25	1901. Dec. 25
Morris Machine Works, Baldwinsville, N. Y.	Centrifugal pump and engines.	8,338.00	Apr. 29	May 10	Nov. 10
	Propelling engines, etc	5,025.00	....do...	....do...	Do.
Wheeler Condenser and Engineering Co., New York, N. Y.	Condenser	2,498.00	May 14	May 21	Nov. 21
Thos. P. Benton & Son, La Crosse, Wis.	Electric-light plant	1,050.00	Apr. 25	May 8	Nov. 8
New Jersey Foundry and Machine Co., New York, N. Y.	Distilling plant	1,090.00	May 3	May 11	Nov. 11
	Jet pumps, feed pumps, etc.	1,600.00	....do...	....do...	Do.
Henry Vogt Machine Co., Louisville, Ky.	Boilers	3,945.00	Apr. 29	May 7	Nov. 7
Memphis Machine Works, Memphis, Tenn.	Refrigerating plant	1,295.00	Apr. 30	May 6	Nov. 6
Arthur Fritsch Foundry and Machine Co., St. Louis, Mo.	Steam spud lift, suction frame and fittings, etc.	5,293.50	(a)	Aug. 7	Nov. 27
Crane Co., St. Louis, Mo	Piping, valves, and fittings.	1,760.00	(a)	1902. Mar. 8	1902. Apr. 10

[a] Emergency contract.

COMMERCIAL STATISTICS.

No commercial statistics for the fiscal year ending June 30, 1902, could be obtained. Inquiries by letter were made, but no replies have been received up to June 30, 1902.

REPORT OF MR. E. M. HARTRICK, ASSISTANT ENGINEER.

GALVESTON, TEX., *July 2, 1902.*

CAPTAIN: I have the honor to submit the following report of operations for improvement of Brazos River, Texas, between Velasco and Richmond, West Bay Channel Double Bayou, and mouth of adjacent streams, during the fiscal year ending June 30, 1902.

No work of dredging or snagging during the year was done, as the plant for such work was under construction and had not been completed.

At the beginning of the fiscal year the plans and specifications for the dredge were complete and bids for the various parts advertised and contracts awarded. See abstract of bids, Annual Report Chief of Engineers, 1901, page 1951.

The contractor for hull commenced work on August 10, 1901, at Texas City, and completed same February 24, 1902. On February 27, 1902, the dredge *Gen. H. M. Robert* was towed to Galveston to have deck house and cabin properly erected over hull. The contractor commenced work on March 10, 1902, and completed on June 17, 1902.

The contractors for pump, propelling engine, condenser, electric-plant jet, and feed pump, boilers, and refrigerating plant delivered same as the work progressed, and by June 21, 1902, everything was installed on board the dredge ready for testing and trial run. The installation was supervised and work was done by Capt. William J. Lynch, who will be master and chief engineer of the boat, assisted by the engine-room force, who will operate the dredge. The boat is now taking on board her outfit and supplies and will test her machinery in a few days, after which she will proceed up the bay and be put to work in accordance with the submitted project.

DESCRIPTION OF DREDGE.

The dredge *H. M. Robert* is a light-draft, self-propelling, twin-screw, hydraulic dredge. The hull is 132 feet long, 32 feet wide, and 7½ feet deep, and draws 4 feet loaded and ready for work.

Her runner is 72 inches in diameter, inclosed type. Suctions enter on both sides of pump and discharge through a 20-inch pipe from either side of dredge, as desired.

The outboard delivery pipes are suspended from shear legs and can handle the pipe as occasion may require for depositing the spoil on shore or to form banks alongside the cut as the channel advances. If necessary, a ponton pipe line can be rigged to deposit at long distance from cut.

The pump is driven by a vertical triple-expansion four-cylinder engine arranged in two units, the shafts being connected to pump shafts by flanged couplings. The high-pressure cylinder is 14 inches in diameter, the intermediate is 21 inches, and the two low-pressure cylinders are each 23½ inches in diameter, with a common stroke of 18 inches. The engines will run at 150 revolutions per minute, giving the pump a peripheral velocity of 47 feet per second, which will maintain a head of 34¼ feet with a pump efficiency of 60 per cent.

The dredge is propelled by twin screws 4 feet 9 inches in diameter and 5 feet 9 inches pitch, fitted with removable blades. Owing to the shallow draft of the boat, the propellers project 12 inches above the water line and are covered with hoods, which will give the same effect as though they were entirely submerged. The engines are compound, with high-pressure cylinders 12 inches, low-pressure cylinders 22 inches in diameter and 12 inches stroke, and are located at the after end of the engine room.

Steam is furnished by three boilers of locomotive type, but having combustion chambers extending between the furnace and the tubes. The boilers are 5 feet diameter of barrel, 7 feet 3 inches height in front, and 18 feet 6 inches length. The furnaces are 5 feet long, combustion chambers 3 feet 3 inches long, and each boiler contains 104 tubes 2¼ inches diameter and 10 feet long. The total grate surface is 75 square feet and the total heating surface 2,400 square feet.

The dredge is fitted for sand digging only. The machinery and cutter head for handling stiff clay and other compact material will be added later. The suction head mouthpiece is 9½ feet wide and is fitted with screen bars and a water-jet agitator for loosening the sand. There are seven pipes leading radially to the under side of the mouth, reduced at the end to five-eighths inch. The water supplied at those jets is at a pressure up to 100 pounds to the square inch.

When working in soft, free-flowing material, the dredge will be fed into the cut by head cables anchored at convenient distances and hauled in by the steam capstans on forward deck. These capstans are driven by pairs of horizontal engines with 6-inch cylinders and 8-inch stroke. A pair of smaller capstans with 5 by 7 inch engines are placed abaft the engine house for handling the discharge pipes and general purposes. When dredging in hard material, which requires the cutter head to disintegrate it, the feeding will be done by swinging from the spud anchor located at the after end of the engine house. Head lines will be used for the advance and breast lines for the swing. The spud anchor will be raised by means of a steam cylinder 15 inches diameter and 6 feet stroke, and is dropped by a tripping dog, which engages on a rack in the face of the spud. The bow sheers are made from selected sticks of yellow pine 10 inches square, and are intended for use in clearing the channel from snags as well as for handling the suction head.

In addition to the foregoing machinery, the boat is fitted with electric-light plant, evaporating and refrigerating plant, machine and blacksmith shops, and machine tools.

The cabins can accommodate a crew of 30 men, besides an office and stateroom for inspecting officer. There are also bathrooms for officers and crew, cold-storage room, with kitchen and mess room.

Very respectfully, your obedient servant,

E. M. Hartrick, *Assistant Engineer.*

Capt. C. S. Riché, *Corps of Engineers.*

U 8.

IMPROVEMENT OF TRINITY RIVER, TEXAS.

* * * * * * *

No work was done during the present fiscal year, nor has any been done since operations were suspended in 1894 on the improvements at the mouth of the river, known as the Middle Pass, the construction of East Jetty having been postponed until sufficient funds were on hand to enable it to be built quickly and economically.

In future, work on the mouth of this stream will be conducted by dredging and snagging, in connection with appropriation for the improvement of the Brazos River between Velasco and Richmond, West Galveston Bay channel, Double Bayou, and the mouths of adjacent streams. (See report herewith on improvement of the Brazos River between Velasco and Richmond, West Galveston Bay channel, Double Bayou, and the mouths of adjacent streams.) Upon completion of the combined dredge and snag boat now building under this latter appropriation, dredging will be undertaken at the mouth of Trinity River, to obtain a channel 6 feet deep from Galveston Bay across Browns Flats to the mouth of Browns Pass.

Amount expended on this improvement to June 30, 1902, $77,249.37.

Money statement.

July 1, 1901, balance unexpended	$6,750.63
July 1, 1902, balance unexpended	6,750.63

ABSTRACT OF APPROPRIATIONS MADE BY CONGRESS FOR IMPROVING TRINITY RIVER, TEXAS.

By act of—		By act of—	
June 18, 1878	$10,000	July 13, 1892	$10,000
March 3, 1879	2,500	August 18, 1894	5,000
June 14, 1880	4,000	June 3, 1896	5,000
March 3, 1881	10,000	March 3, 1899	7,000
August 2, 1882	8,000		
August 11, 1888	12,500	Total	84,000
September 19, 1890	10,000		

COMMERCIAL STATISTICS OF TRINITY RIVER, TEXAS, FOR THE FISCAL YEAR ENDING JUNE 30, 1902.

Vessels using the river, 20 (2 steam vessels, 8 barges, and 10 sailing vessels); draft, 4 feet; total tonnage, 5,000.

Amount and value of freight transported.

Articles.	Amount.	Approximate value.
	Tons.	
Lumber	7,000	$35,000.00
Wood	1,500	4,000.00
General merchandise	300	6,000.00
Total	8,800	45,000.00

U 9.

IMPROVEMENT OF CEDAR BAYOU, TEXAS.

No work was done up to the close of the fiscal year except to submit a project for the expenditure of the amount appropriated by the river and harbor act approved June 13, 1902.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902	$5,000.00
July 1, 1902, balance unexpended	5,000.00

ABSTRACT OF APPROPRIATIONS MADE BY CONGRESS FOR IMPROVING CEDAR BAYOU, TEXAS.

By act of—	
September 19, 1890	$18,150
July 13, 1892	14,000
July 13, 1902	5,000
Total	37,150

U 10.

IMPROVEMENT OF CHANNEL IN WEST GALVESTON BAY, TEXAS.

* * * * * * *

No work was done during the present fiscal year because a greater depth of water exists in the bay than is found in the Galveston and Brazos Canal, owned by a private corporation having the right to levy tolls, through which most vessels plying between Galveston and the Brazos River passed. The condition of this canal is described in House Doc. No. 447, Fifty-sixth Congress, first session, printed also on pages 2418–2425 of the Annual Report of the Chief of Engineers for 1900.

The canal can be purchased for $30,000, which is less than it would cost to reproduce existing conditions if the canal had never been built.

In future, work on this improvement will be conducted in connection with appropriation for improvement of the Brazos River between Velasco and Richmond, West Galveston Bay channel, Double Bayou, and the mouths of adjacent streams. (See report herewith on improvement of the Brazos River between Velasco and Richmond, West Galveston Bay channel, Double Bayou, and the mouths of the adjacent streams.) Upon completion of the combined dredge and snag boat now building under this latter appropriation, dredging will be undertaken in West Galveston Bay channel, and the money available will all probably be expended during the coming fiscal year.

Total amount expended on this improvement to June 30, 1902, $19,775.97.

Money statement.

July 1, 1901, balance unexpended	$5,224.03
July 1, 1902, balance unexpended	5,224.03

ABSTRACT OF APPROPRIATIONS MADE BY CONGRESS FOR IMPROVING CHANNEL IN WEST GALVESTON BAY, TEXAS.

By act of—	
July 13, 1892	$15,000
August 18, 1894	5,000
June 3, 1896	5,000
Total	25,000

COMMERCIAL STATISTICS.

No commercial statistics for the fiscal year ending June 30, 1902, could be obtained. Inquiries by letter were made, but no replies have been received up to June 30, 1902.

U 11.

IMPROVEMENT OF BRAZOS RIVER, TEXAS.

* * * * * * *

No work was done during the fiscal year.

In future, work on this improvement will be conducted in connection with appropriation for the improvement of the Brazos River between Velasco and Richmond, West Galveston Bay channel, Double Bayou, and the mouths of adjacent streams. (See report herewith on the improvement of the Brazos River between Velasco and Richmond, West Galveston Bay channel, Double Bayou, and the mouths of adjacent streams.) Upon completion of the combined dredge and snag boat now building under this latter appropriation, the removal of snags, etc., from Brazos River will soon be undertaken, and the money available will all probably be expended during the coming fiscal year.

Amount expended on this improvement to June 30, 1902, $22.35.

Money statement.

July 1, 1901, balance unexpended	$4,977.65
July 1, 1902, balance unexpended	4,977.65

APPROPRIATION.

June 3, 1896	$5,000

COMMERCIAL STATISTICS.

No commercial statistics for the fiscal year ending June 30, 1902, could be obtained. Inquiries by letter were made, but no replies have been received up to June 30, 1902.

U 12.

IMPROVEMENT OF BRAZOS RIVER, TEXAS, FROM RICHMOND TO OLD WASHINGTON.

No work has been done up to the close of the fiscal year, except to submit a project for expenditure of the amount appropriated by the river and harbor act approved June 13, 1902.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902	$150,000.00
July 1, 1902, balance unexpended	150,000.00
Amount (estimated) required for completion of existing project	50,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	50,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

ABSTRACT OF APPROPRIATIONS MADE BY CONGRESS FOR THE IMPROVEMENT OF BRAZOS RIVER, TEXAS, FROM RICHMOND TO OLD WASHINGTON.

By act of June 13, 1902	$150,000

U 13.

IMPROVEMENT OF THE MOUTH OF BRAZOS RIVER, TEXAS.

No work was done during the fiscal year.

For condition of work to June 30, 1901, see Annual Report of the Chief of Engineers for 1901, pages 1940 et seq., and House Doc. No. 133, Fifty-sixth Congress, second session.

Project for the expenditure of the amount appropriated by river and harbor act approved June 13, 1902, has been submitted. Up to close of fiscal year same had not been received approved.

The amount expended during the fiscal year was $350, withdrawn by the Office of the Chief of Engineers for expenses of that office; 86 cents for telegram, and 97 cents for Treasury settlement claim No. 55200.

Total amount expended on this improvement to January 30, 1902, $230,622.56.

Money statement.

July 1, 1901, balance unexpended	$13,479.27
Amount appropriated by river and harbor act approved June 13, 1902	50,000.00
	63,479.27
June 30, 1902, amount expended during fiscal year	351.83
July 1, 1902, balance unexpended	63,127.44
Amount (estimated) required for completion of existing project	275,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	275,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

ABSTRACT OF APPROPRIATIONS MADE BY CONGRESS FOR IMPROVING MOUTH OF BRAZOS RIVER, TEXAS.

By act of—		By act of—	
June 14, 1880	$40,000	March 3, 1899	$85,000
March 3, 1881	40,000	June 13, 1902	50,000
August 2, 1882	50,000		
July 5, 1884	10,000	Total	293,750
August 5, 1886	18,750		

COMMERCIAL STATISTICS.

No commercial statistics for the fiscal year ending June 30, 1902, could be obtained. Inquiries by letter were made, but no replies have been received up to June 30, 1902.

U 14.

IMPROVEMENT OF ARANSAS PASS, TEXAS.

At the beginning of the present fiscal year articles of agreement were being prepared with Charles Clarke & Co., of Galveston, Tex., for repairing the north or curved jetty. Articles of agreement were approved July 19, 1901.

Contractors began active operations on October 1, 1901, and completed all work under their contract by April 23, 1902.

Eleven thousand five hundred thirty-four and seventy-six one-hundredths tons of riprap, and 10,737.11 tons of block were used in the work, completing 1,300 feet of the jetty.

SURVEY.

The report of Mr. F. Oppikofer, assistant engineer, gives detailed description of the surveys during the year. Attention is also invited to the map submitted with this report.

Project for expenditure of amount appropriated by river and harbor act approved June 30, 1902, has been submitted for approval.

A detailed account of the work during the fiscal year will be found in the report of Mr. F. Oppikofer, assistant engineer, forwarded herewith, to which attention is invited.

Amount expended on this improvement to June 30, 1902, $635,660.92, exclusive of $9,938.93 subscribed by the citizens of Rockport and Corpus Christi.

Money statement.

July 1, 1901, balance unexpended	$92,555.28
Amount appropriated by river and harbor act approved June 13, 1902	250,000.00
	342,555.28
June 30, 1902, amount expended during fiscal year	86,966.20
July 1, 1902, balance unexpended	255,589.08
July 1, 1902, outstanding liabilities	405.03
July 1, 1902, balance available	255,184.05
Amount (estimated) required for completion of existing project	1,430,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to balance unexpended July 1, 1902	300,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

ABSTRACT OF APPROPRIATIONS MADE BY CONGRESS FOR IMPROVING ARANSAS PASS AND BAY, TEXAS.

By act of—		By act of—	
March 3, 1879	$35,000	August 11, 1888	$100,000
June 14, 1880	65,000	March 3, 1899	60,000
March 3, 1881	80,000	June 13, 1902	250,000
August 2, 1882	100,000		
July 5, 1884	100,000	Total	891,250
August 5, 1886	101,250		

CONTRACT IN FORCE DURING FISCAL YEAR FOR IMPROVING ARANSAS PASS, TEXAS.

Contractor: Charles Clarke & Co., Galveston, Tex.
Character of work: Repairing jetty.
Rates: Riprap in place, $3.30 per ton; large blocks in place, $3.95 per ton.
Date of approval: July 19, 1901.
Date of beginning work: October 1, 1901.
Date of expiration: Contract time waived; contract completed April 23, 1902.

COMMERCIAL STATISTICS.

No commercial statistics for the fiscal year ending June 30, 1902, could be obtained. Inquiry by letter was made, but no reply had been received up to June 30, 1902.

Attention is invited to the discussion of the commercial features of this improvement contained in the appended report of Assistant Engineer F. Oppikofer.

REPORT OF MR. F. OPPIKOFER, ASSISTANT ENGINEER.

GALVESTON, TEX., *July 14, 1902.*

CAPTAIN: I have the honor to submit the following report of Aransas Pass improv ment:

The work was commenced October 10, 1901, under contract with Charles Clar & Co., and completed April 23, 1902.

Before the commencement of the work the jetty between stations 20 and 40 w submerged, and between stations 28 and 31 a gap existed through which the curre ebbed and flooded. In compliance with your verbal instructions, the closing of th gap was the first operation undertaken to divert the escaping current into its prop channel. When this had been accomplished, the immediate result observed was scour of 10 feet depth along the toe of south slope, between stations 31 and 40. Th jetty has practically been constructed in 20 feet depth of water, and has been co pleted in conformity with the specifications from stations 40 to 27, a distance of 1,3 feet, utilizing the old structure to the best advantage. There is no doubt that if t gap between stations 28 and 31 had been closed in order of the work of constructio which was from station 40 shoreward, considerable undermining of the complet work would have taken place.

The amount and value of material used under this contract is as follows:

11,534.76 tons of riprap, at $3.30	$38,064.
10,737.11 tons of block rock, at $3.95	42,411.

A new system of triangulation has been established, based on the Coast and Ge detic Survey triangle L. H., Entrance, L. S. S. and the L. M. Zs., and rectangul coordinates in meters, yards, and feet of 17 stations have been computed.

The channel found from soundings of May, 1902, is tortuous and shows a pr nounced tendency to sweep seaward in an easterly direction at D and again near forced to do so by the shoal forming from the south of Mustang Island, near wre *Mary*, during the summer months.

The prevailing currents in the Gulf, along the coast near Aransas Pass, are fro the south, and tend to maintain and extend this shoal, and must eventually, if t present structure of the north jetty is built up from B to F, create a new bar acro the channel and bring about new physical conditions, caused by the retarded wate cutting another channel, probably between D and B, by undermining the existi work, as it has done previously between stations 28 and 31. At present a large pe centage of the water escapes with the ebb between Mustang Island and wreck *Mar* due to natural slopes or gravity, and since the survey was made has deepened th locality 2 to 3 feet. All these conditions are more or less reversed during the wint months, when the prevailing direction of the wind is from north to east, causing t Gulf currents to flow from the north and demonstrating clearly the necessity of second or south jetty to create and maintain a navigable channel. The whole a only effect of the single curved jetty, as noted through the last eight months, h been to form a narrow channel in close proximity to it, the sinuosity and narro ness of which, however, will not permit the pilots to bring in vessels drawing ov 10 feet, although the minimum depth in its thalweg is 14½ feet. Under present co ditions the point B on the jetty represents the critical position. The sweep of t tide here is restrained from forcing an unobstructed flow seaward, as the submerg enrockment from B to F interposes an impediment which interrupts the outwa current in its attempt to work its course northeasterly. It is, therefore, beyo doubt that the structure of the curved jetty from B to F should be obliterated a the course of the jetty diverted from B seaward, in accordance with the plans of t Board of United States Engineers.

I would respectfully recommend a careful study of the channel between D and during the building up of the present jetty from D seaward under the next contr by means of a system of cross sections to enable you to demonstrate the value of t jetty between B and F. In this connection I beg to call your attention to the pla of reference for soundings used at Aransas Pass and its difference from actual me low tide. This plane is at least one-half foot above mean low tide and was establish in June, 1885, from 22 maximum and 21 minimum tides with Galveston (Book D box 6, p. 60), evidently by use of Mitchell's rules. Aside from the short durati of these comparative readings with Galveston's plane of reference, it is safe to assu another factor of error from the slope between the two planes. In view of the fa that the United States Engineer Department will develop a deep harbor at Arans Pass, I would respectfully recommend the erection of an automatic tide gauge for t establishment of a more correct plane of mean low tide.

COMMERCIAL STATISTICS.

official report of the comptroller of the State of Texas for the year 1900 puts sessed value of the real estate for that year in territory nearer to Aransas Pass to any other port at $200,000,000, the number of cattle in that territory at 000 head, the number of sheep at 1,000,000 head, and the number of horses at 000 head in round numbers.

cotton reports made by the counties in above territory for the year 1900 show luct of about 600,000 bales.

collector of customs for the Corpus Christi district, which includes only part territory tributary to Aransas Pass, shows, for the fiscal year ending June 30, that the imports amounted to $4,652,619 and the exports to $7,089,909. at present but a small proportion of this commerce comes through Aransas it is believed that the greater part of it will pass through this harbor if opened nmerce.

report of the land commissioner of the State of Texas shows that he has sold ual settlers in that territory within the last year, in round numbers, 2,000,000

Very respectfully, your obedient servant,

F. Oppikofer,
Assistant Engineer.

t. C. S. Riché,
Corps of Engineers.

RECTANGULAR COORDINATES.

ulation stations and beacons, Aransas Pass, Texas, light-house origin of coordinates.

ch station or point the upper figures are meters, middle figures yards, and lower figures feet.]

Station.	North.	South.	East.	West.
ouse	0	0	0	0
		1,098.915 1,201.785 3,605.355	666.291 728.663 2,185.989	
		1,246.127 1,362.778 4,088.333	759.976 831.120 2,493.355	
		1,905.572 2,083.954 6,251.860		1,157.512 1,265.869 3,792.604
		2,018.357 2,207.296 6,621.890	819.604 896.328 2,688.983	
		2,356.626 2,577.248 7,731.730		208.476 227.998 683.975
		2,424.673 2,651.649 7,954.947		56.154 68.115 204.345
		2,585.225 2,827.230 8,481.700	887.312 970.373 2,911.120	
		2,806.783 3,942.855 1,828.564	347.155 379.652 1,138.957	
		2,889.657 3,160.160 9,480.478		257.108 281.176 843.529
		2,901.369 3,172.968 9,518.904	1,383.227 1,512.712 4,538.137	
Mary		3,324.079 3,635.249 10,905.746	1,446.402 1,581.800 4,745.400	
ce		3,272.272 3,578.592 10,735.777	807.193 882.755 2,648.266	
		2,969.539 3,247.520 9,742.561	358.767 392.351 1,177.052	
		3,519.251 3,848.690 11,546.069	201.312 220.157 660.470	
		3,842.126 4,201.790 12,605.870	253.565 277.801 831.904	
		4,004.240 4,379.080 13,137.241	160.440 175.459 526.877	

U 15.

IMPROVEMENT OF HARBOR AT BRAZOS SANTIAGO, TEXAS.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$55,186.84
June 30, 1902, amount expended during fiscal year	350.00
July 1, 1902, balance unexpended	54,836.84

ABSTRACT OF APPROPRIATIONS MADE BY CONGRESS FOR IMPROVING HARBOR AT BRAZOS SANTIAGO, TEX.

By act approved—	
June 14, 1880	$25,000
March 3, 1881	75,000
August 2, 1882	60,000
July 5, 1884	25,000
August 5, 1886	$37,500
August 11, 1888	25,000
Total	247,500

COMMERCIAL STATISTICS.

No commercial statistics for the fiscal year ending June 30, 1902, could be obtained. Inquiries by letter were made, but no replies have been received up to June 30, 1902.

U 16.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

At the beginning of the fiscal year contract had been entered into with Drouet & Bryant, of Galveston, Tex., and forwarded for approval, for removing the following wrecks:

Steamer *Cumberland*, wooden hull; gross tonnage, 119; length, 124 feet; breadth, 21.5 feet; depth, 7.5 feet; built in 1882. Lies in about 23 feet of water in Galveston channel, off Pier 23, Galveston, Tex.

An iron oil tank, 40 feet long and 7 feet in diameter, lies about 1¼ miles from shore in about 6 feet of water, between Texas City and Dollar Point, Dollar Point being west 1¼ miles.

Barge *Jules*, wooden hull; gross tonnage, 230; length, 162 feet; breadth, 29 feet; depth, 8 feet; built in 1892. Lies north of Edwards Point in about 6 feet of water. Red Fish light bears S. 85° E. 2¼ miles.

Barge *Alice*, wooden hull; gross tonnage, 90; length, 120 feet; breadth, 20 feet; depth, 6½ feet. Lies at south end of Morgans Canal in about 9½ feet of water.

Tug *Kate*, wooden hull; gross tonnage, 30; length, 60 feet; breadth, 14 feet; depth, 6½ feet. Lies in San Jacinto River, bottom up, about 2,000 feet above Lynchburg post-office, in about 8½ feet of water.

Contract of Drouet & Bryant was approved, and contractors started active operations on July 11, 1901, and completed removing all the wrecks on October 22, 1901.

The amount allotted for the removal of these wrecks was $2,500, and was expended as follows:

Printing specifications	$33.36
Advertising for bids	17.53
Drouet & Bryant, removing wreck, steamer *Cumberland*	749.00
Drouet & Bryant, removing wreck, barge *Jules*	420.00
Drouet & Bryant, removing wreck, barge *Alice*	420.00
Drouet & Bryant, removing wreck, tug *Kate*	300.00
Drouet & Bryant, removing iron oil tank	100.00
Notary fee to affidavit to contract for returns office	.25
Superintendence and inspection, office expenses, etc	452.13
Total cost of removing wrecks	2,492.27
Deposited to credit of the appropriation	7.73
	2,500.00

Under date of February 25, 1902, authority was granted and an allotment of $3,000 was made from the indefinite appropriation made by section 20 of the river and harbor act of March 3, 1899, for removing wrecks in Galveston Bay and Buffalo Bayou, Texas, as follows:

Dredge No. 3, wooden hull; gross tonnage, 90; length, 100 feet; breadth, 36 feet; depth, 10 feet; built in 1891 at Galveston, Tex. Burned June 30, 1901. Contained Osgood dredging machinery, part of which has been removed. Lies on north bank of Galveston channel, about 1,000 feet northeast from Red beacon, in from 18 to 24 feet of water.

Barge No. 3, decked, wooden hull; length, 131 feet; breadth, 23 feet; depth, 5 feet. Supposed to have been sunk during hurricane of September 8, 1900. Lies on north side of channel in Buffalo Bayou, below mouth of Greens Bayou, in Massies Reach, in from 8 to 10 feet of water.

Dredge boat, wooden hull; length, 65 feet; breadth, 27 feet; depth, 6 feet. Sunk during hurricane of September 8, 1900. Is a crane dredge of the Osgood type. Boiler and machinery supposed to be complete. Lies just south of channel in Buffalo Bayou, about 500 feet above upper end of Clinton wharf, in from 12 to 20 feet of water.

Flatboat *Daisy*, open hold, wooden hull; length, 75 feet; breadth, 22 feet; depth, 5½ feet. Sunk against south bank of Buffalo Bayou, on point just above Inman compress. Date of wreck unknown.

Bids for removing these wrecks were advertised for March 15, 1902, and opened April 14, 1902. Three bids were received, and contract was awarded to Charles J. Bryant, of Galveston, Tex., and same approved.

The bid of Charles J. Bryant is as follows:

Removing dredge No. 3	$1,150
Removing barge No. 3	300
Removing dredge boat	600
Removing flatboat *Daisy*	100
Total of bid	2,150

At close of fiscal year the contractor was removing the wreck of dredge No. 3, and had nearly completed same.

The amount expended to June 30, 1902, for removing these wrecks is as follows:

Printing specifications	$26.98
Advertising for bids	19.38
Office expenses	75.83
Total	122.19

CONTRACTS IN FORCE DURING FISCAL YEAR.

For removing wrecks steamer Cumberland, iron oil tank, barge Jules, barge Alice, and tug Kate.

Contractor: Drouet & Bryant, Galveston, Tex.
Character of work: Removing wrecks.
Rate: Steamer *Cumberland*, $749; barge *Jules*, $420; barge *Alice*, $420; tug *Kate*, $300, and iron oil tank, $100.
Date of approval: July 5, 1901.
Date of beginning work: July 11, 1901.
Date of expiration: November 6, 1901. (Contract completed October 28, 1901.)

For removing wrecks dredge No. 3, barge No. 3, dredge boat, and flatboat Daisy.

Contractor: Charles J. Bryant, Galveston, Tex.
Character of work: Removing wrecks.
Rate: Dredge No. 3, $1,150; barge No. 3, $300; dredge boat, $600; flatboat *Daisy*, $100.
Date of approval: May 7, 1902.
Date of beginning work: June 11, 1902.
Date of expiration: September 16, 1902.

U 17.

EXAMINATION AND SURVEY OF INNER HARBOR OF GALVESTON, TEX.

[Printed in House Doc. No. 91, Fifty-seventh Congress, first session.]

Office of the Chief of Engineers,
United States Army,
Washington, December 7, 1901.

Sir: I have the honor to submit the accompanying copies of reports, dated November 14, 1900, and January 29, 1901, with illustrations,[a] by Capt. C. S. Riché, Corps of Engineers, upon preliminary examination and survey, respectively, of the inner harbor of Galveston, Tex., authorized by the emergency river and harbor act approved June 6 1900.

In my opinion the work covered by this survey is of importance to local interests rather than to general commerce, and its undertaking by the General Government is a proposition I am unable to commend for favorable consideration.

Reports upon preliminary examination and survey of Galveston Bay, from the Gulf of Mexico to Fifty-first street, Galveston, were transmitted to Congress at its last session, and are printed in Part II of the Annual Report of the Chief of Engineers for 1901, at pages 1959 and 1967, respectively.

Very respectfully, your obedient servant,

G. L. Gillespie,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. Elihu Root,
Secretary of War.

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[a] Not printed; printed in House Doc. No. 91, Fifty-seventh Congress, first session.

REPORT OF CAPTAIN C. S. RICHÉ, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., November 14, 1900.

GENERAL: In response to your letter dated June 13, 1900, I now have the honor to submit the following report upon the preliminary examination of the inner harbor of Galveston, Tex., as required by the following item in the emergency river and harbor act of June 6, 1900:

> Also for survey and making plans for improvement of inner harbor of Galveston.

An entrance channel from the Gulf of Mexico into Galveston Harbor, of ample navigable capacity, is now an assured fact, and this channel is the natural outlet for the products of an extent of country equal in area to about one-fifth of the United States.

As yet the country thus dependent upon Galveston Harbor is undeveloped, as compared with other portions of the United States, but its products and population are increasing at a rapid rate, and existing terminal facilities at Galveston are frequently taxed to their full capacity.

The present water front of inner Galveston Harbor available for deep-draft vessels is along the bay side of the city of Galveston, and is about 3 miles in length, about 2 miles of this distance being now occupied by wharves and other terminal facilities.

With the growth in commerce of the port, which is bound to accompany the growth in population and resources of the southwestern part of the United States, these 3 miles of available water front will soon become inadequate for handling the business that can reasonably be expected, and additional frontage for deep-draft vessels will become necessary.

In order that this additional frontage may be provided as it is needed, it is advisable that a comprehensive plan for the ultimate development of the inner harbor should now be adopted, to the end that future works of improvement may be in line with the essential features of such a plan, and that measures and policies inconsistent with such plan may be avoided.

In connection with several matters involving the policy of the Government in regard to the further development of the inner harbor, the Division Engineer, Col. Henry M. Robert, has discussed with representative citizens of the locality the advisability of the adoption of a plan of sufficiently comprehensive character, in order to ascertain whether or not such plan would prove satisfactory to the various interests affected.

In brief, this plan consists in closing the channel between Pelican Island and the mainland, usually known as Half Moon channel, by a dike which would extend from the mainland near Texas City to the easternmost portion of Pelican Spit Flats. The construction of this dike once assured, the channel to West Bay, which is crossed by the railways on a long trestle, could be closed for all but such short distance as would be needed to permit the passage of light-draft vessels to and from West Bay. The closing of this latter channel would be done by the railways themselves, in order to save a considerable annual expenditure on their part for maintenance of trestle.

In this manner a nearly landlocked harbor would be formed, which could be developed from time to time by dredging, and in which the cost of maintaining dredged channels would be trifling. The size of this harbor would be sufficient to enable the increasing business of the port to be taken care of for many years to come.

The present adoption of the essential features of a plan of this character is advisable, and to at least that extent the inner harbor of Galveston is now worthy of improvement.

Information is already available that will permit the proposed plan to be submitted in sufficient detail for present purposes. Some office work will be necessary, and for this sufficient funds are on hand.

Attention is invited to the inclosed extracts[a] from the Galveston News, which describe in considerable detail the discussions on this subject between Colonel Robert and representative citizens of Galveston and vicinity, and which give the views of those interested in the matter.

Very respectfully, your obedient servant,

C. S. RICHÉ,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. Army.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, November 26, 1900.

Respectfully forwarded to the Chief of Engineers, United States Army.

I concur with the district engineer in his opinion that the inner harbor of Galveston is worthy of improvement by the General Government.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
December 3, 1900.

Respectfully submitted to the Secretary of War.

This is a report upon preliminary examination of the inner harbor of Galveston, Tex., required by the provisions of the emergency river and harbor act of June 6, 1900.

The local officer is of opinion, concurred in by the division engineer, that this inner harbor is worthy of being improved by the General Government.

I recommend that the local officer be directed to prepare a plan and estimate of cost of improvement as outlined in the within report, a survey in the ordinary sense not being necessary for present purposes.

Attention is respectfully invited in this connection to Captain Riché's report of November 15 upon preliminary examination of Galveston Bay, and to my indorsement thereon of this date submitting it to the Secretary.

JOHN M. WILSON,
*Brig. Gen., Chief of Engineers,
U. S. Army.*

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[a] Not printed.

[Third indorsement.]

WAR DEPARTMENT,
December 6, 1900.

Approved as recommended by the Chief of Engineers.

ELIHU ROOT,
Secretary of War.

SURVEY OF THE INNER HARBOR OF GALVESTON, TEX.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., January 29, 1901.

GENERAL: In accordance with your instructions, I now have the honor to submit a report upon a survey of inner harbor of Galveston, Tex., with a view to making plans for its improvement, as required by the following item in the emergency river and harbor act of June 6, 1900:

> Also for survey and making plans for improvement of inner harbor of Galveston.

The general features of a plan for improving this inner harbor were outlined in a previous report upon its preliminary examination submitted to you under date of November 14, 1900. In this connection attention is also invited to the map accompanying the present report.

The dike from the mainland near Texas City to the easternmost portion of Pelican Spit Flat forms the essential feature of the proposed plan. Its main purpose is to close Half Moon channel, but it should be extended along the north side of Pelican Island and Spit to prevent the cutting away of these islands by the new currents that would be formed.

Where the location of the dike is on the land side of established harbor lines a right of way or a permit to construct the dike will have to be obtained from the riparian owners. It is thought that there will be no trouble in obtaining this without cost, so no item for expense of this character is included in the estimate.

As the dike is liable to be severely strained by storms during its construction and afterwards, it is thought that it should be constructed in a substantial manner. Subsequently, no reasonable opportunity should be neglected for the deposit of excavated material on the southern side of the dike.

The proposed method of construction is described in the report of Assistant Engineer E. M. Hartrick (inclosure 1, herewith), to which, and to the accompanying drawing showing cross sections of the proposed structure, attention is invited. The uncertainties attending the completion of any less substantial structure are so great that it is believed that the best results will be obtained from the character of construction shown. The estimated cost of the dike as proposed is $2,250,000.

It is manifest from the conditions of the case that a partial construction of the dike will be detrimental to the harbor, and not beneficial. The dike should not be commenced unless sufficient funds are available to carry it to completion as rapidly as possible.

Once constructed, this dike will enable several important improvements to be made.

First. West Bay channel between Virginia Point and Galveston Island, where the railways cross from the mainland, can then be closed by the railways, leaving an opening of but from 200 to 300 feet for the small-boat traffic to and from West Bay.

In advance of funds for the construction of the dike becoming available, I believe that the railways should not be permitted to make this channel materially narrower than it is at present. The locality has been visited by many storms which first fill Galveston Bay with water, and then, owing to a change of wind to the north, drive this water out again to the Gulf.

For such storms the channel referred to acts as a sort of wasteweir or spillway and enables much of the accumulated water to escape into West Bay. Were this channel closed in advance of the construction of the proposed dike, this accumulated water would be unable to escape into West Bay and would be forced across Galveston Island, where it would cause much damage to property and possibly loss of life in and near the city of Galveston.

Once the proposed dike has been constructed, however, the water accumulated in Galveston Bay by a storm would, when driven out by a north wind, be deflected by the dike into the channel between the Galveston jetties, where a great part of its force would be expended in more deeply scouring the entrance channel. The city and harbor of Galveston would then be very much safer from storms of this character than they are to-day, and West Bay channel, where the railways cross from the mainland, could be closed by the railways without danger.

The conditions above described are those which occur during the average great storm that visits Galveston. In the past such storms have occurred about once every ten or fifteen years. The greatest storm of this character whose effects were recorded was in September, 1875.

The hurricane of September 8, 1900, as experienced at Galveston, differed considerably from previous storms. The water, instead of being piled up before the wind, seemed for a part of the time to concentrate toward the point of lowest barometer, and at Galveston rose to an unprecedented height. At the time when Galveston was covered with water it is reliably reported that Upper Galveston Bay was quite low, the period of highest water occurring there later than it did at Galveston. This would indicate that much of the water that covered Galveston had an outlet over and up the bay.

If the dike had been in existence at the time of this hurricane the draining off of the water might have been retarded, and for this reason it is thought inadvisable to put the crest of the dike, when first constructed, higher than 10 feet above mean low tide, which will give a height of about 8 feet after consolidation and settlement, this being approximately the greatest height reached by the water during the storm of 1875.

The great destruction caused by the hurricane of September 8, 1900, however, was from the action of breakers, and this action was confined during this storm to the Gulf side of the city. To prevent damage of this character it would be necessary to raise the city either to a much greater height than at present or to built a substantial breakwater along its Gulf front. The construction of the proposed dike would prevent breakers from the north reaching the bay side of Galveston.

In view of a likelihood of a repetition of conditions similar to those of the storm of September, 1875, I believe it would be injudicious to construct a breakwater along the Gulf front of Galveston unless this proposed dike had previously been constructed.

In view of all the circumstances, therefore, I fail to see any likelihood of the proposed dike increasing the liability of Galveston to damage from excessive storms. On the contrary, it would make possible the construction of works that would materially reduce such liability to damage.

Second. Another advantage of the proposed dike would be that it would render Pelican Island and Spit accessable by railway from the mainland independently of Galveston. This would permit additional railways to acquire terminals at the port without having to secure rights of way through city streets and without rendering more complex the approaches to existing terminals.

Pelican Island is owned by the city of Galveston under grant from the State of Texas in 1856, confirmed in 1879. The flats between the island and the harbor lines probably belong to the city also. If they do not, then they belong to the State of Texas. It is entirely within the power of the city of Galveston and the State of Texas to make such wise disposition of this property as will best serve the interests of the people dependent upon this port as an outlet.

As Pelican Spit belongs to the United States, having been purchased from the State of Texas in 1859, and as it is understood that it is no longer needed for fortification purposes, it would seem to be within the power of the United States to have this property developed in the interest of the people of the Southwest, but, in my judgment, this need not be done unless the city of Galveston and the State of Texas first fail to take appropriate action.

All this public property would be rendered easily accessible and capable of development for wharves and terminals by the construction of the proposed dike. Without this dike its development is a matter of greater difficulty.

Third. A third advantage of the proposed dike consists in the nearly landlocked harbor which it would form. The present channel in front of the Galveston wharves is the result of natural currents, supplemented toward its western end by dredging, this dredging now being done by the riparian owners. The closing of Half Moon channel by the proposed dike would intercept the chief current that maintains this Galveston channel, and dredging would have to be depended upon for its maintenance.

For this reason the proposed dike should not be built unless the United States be prepared to maintain this channel by dredging.

With the intercepting of the current that maintains this channel, however, is also intercepted the sand that would tend to obliterate it. Consequently, in the basin formed between Galveston Island and the mainland by the proposed dike, channels could be made in any direction desired, and the cost of their maintenance would be trfling. The development of wharves and terminals thus rendered possible would be sufficient to take care of the increasing business of the Southwest for many years.

The changes in the harbor lines that would be required for such a development should be made gradually, as required. The area of the basin outside of the harbor lines should not be made less than 10 square miles, in order that a sufficient tidal flow through Galveston channel for sanitary purposes may not be prevented.

Fourth. A fourth advantage of the proposed dike is its effect on the Texas City channel now under contract. At present this channel is crossed at right angles by Half Moon channel, and its maintenance will, therefore, prove difficult. By closing Half Moon channel the currents which now cross Texas City channel will be deflected into line with it and its maintenance will become much easier.

Two objections to the proposed dike suggest themselves. One lies in its interference with existing bay currents and in the diminution of the tidal prism of the bay as a final result of the great commercial development which the construction of the dike would permit, these changes possibly having a tendency to reduce the scouring force of the tidal currents between the Galveston jetties.

I believe this disadvantage will be somewhat compensated for by the more nearly direct flow of the tidal currents when deflected jettyward by the dike. Especially will this be the case during a storm of the character of that of 1875. Even should there remain an outstanding disadvantage in this regard, it would mean that somewhat more dredging than before would be necessary in the entrance channel between the outer ends of the jetties. The increased cost of this dredging, however, would be trifling when compared to the advantages to commerce of the increased development of wharves and terminals rendered possible.

The other disadvantage lies in the movement of sand, which the construction of the dike would render probable. The closing of Half Moon channel and the deflection of its currents toward the jetties will probably lead to a considerable movement of sand across the entrance to Galveston channel. This movement would continue until an equilibrium had once more been established, after which no serious trouble would be likely from this cause. While this movement of sand was in progress, however, considerable additional dredging would have to be done at the entrance to Galveston channel, but I believe the capacity of the Government dredging plant now at Galveston will be sufficient to take care of this additional work.

On December 21, 1900, I submitted to you a report on widening, deepening, and extending the present Galveston channel. The dimensions of channel therein recommended will interfere in no way with the plans herein proposed.

The maintenance of this Galveston channel will cost less if the proposed dike is constructed. The channel can be maintained without the dike, but its maintenance will cost more. There is one advantage, however, in doing some of the work on Galveston channel before constructing the dike. The work on Galveston channel will enable the city of Galveston to make arrangements for the development of a portion of the Pelican Island property. The action of the city in this matter will show whether or not this property will be developed in reasonable accordance with the interests of the people dependent upon this port as an outlet. If this action prove adverse to such interest, then no dike or other work for enlarging the general facilities of the port should advisedly be undertaken by the United States, as in such case there would be no opportunity for the money expended to return to the people. In such case the United States should either permit a proper development of its own property on Pelican Spit and Flats or else turn its attention to other localities where there might be a reasonable opportunity for the people at large to benefit from the expenditure.

If the port of Galveston is conducted with reasonable regard to the interest of the people of the Southwest, it will be the main outlet for a rapidly growing commerce, and provisions for a continuing increase in facilities for its inner harbor as above outlined should soon be made. In this case the money expended by the United States on the development of this inner harbor would return to the people in the form of reduced charges for transporting and transshipping freight, and there would be no question as to the advisability of the United States inaugurating the work. If, on the contrary, the action of the city of Galveston in regard to the Pelican Island property should be based upon purely local profit, then the commerce of the port will soon cease to grow, and the improvement and maintenance of the inner harbor and channels of Galveston by the United States would become inadvisable and should be left to local energy.

Very respectfully, your obedient servant,

C. S. RICHÉ,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, April 29, 1901.

Respectfully forwarded to the Chief of Engineers, United States Army.

* * * * * * *

The general idea of this plan was suggested to the citizens of Galveston about a year ago in connection with the disposal of the dredged material from the Texas City channel. It was generally considered fatal to Galveston to interfere in any way with Half Moon channel. I tried to convince the representative citizens that a dike built from Texas City to the eastern end of Pelican Spit, cutting off Half Moon channel, would benefit rather than injure Galveston Harbor. I then showed them approximately how they could make a fine inner basin, at least tripling the harbor facilities. I had in view the doing of the work by a syndicate, not the United States. The approach to the inner docks might be purchased and controlled by one party so as to greatly injure the usefulness of the improvement. It seems to me that the United States should not undertake building this dike until it was reasonably satisfied that the inclosed area would really be utilized for commercial purposes.

I have never studied the problem in detail, but it seems to me that if a syndicate controlled the entire matter it could well afford to build the dike, the approaches and docks, and terminal railway, etc., in such a way as to open them to access by all competing railroads. To justify capitalists in investing in such a scheme they would have to have a long lease, fifty or a hundred years; but if this were done Galveston could handle many times its present commerce.

I concur in the views expressed by Captain Riché in all his project herein, excepting I had no idea of such an expensive dike when I stated that I thought the improvement was a worthy one for the Government to make. I do not think the Government should undertake the construction of this dike except on the ground that the dike would protect a large inner harbor and thus greatly increase the usefulness of the Galveston jetties. If the building of this dike would result in the development of a full system of docks covering approximately, 4,000 acres, I think it money well spent by the United States. Of course it is assumed that the city of Galveston would not permit any sewage to flow into its harbor.

* * * * * * *

The plan of the dike could have been better arranged had it not been for the Texas City channel, which complicates the matter. I presume the angle near the shore is caused by this and property interests on the shore.

I would be afraid for the Government to actually build this dike before all questions were settled as to how it was to be utilized.

* * * * * * *

HENRY M. ROBERT,
Colonel, Corps of Engineers,
Division Engineer.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
November 29, 1901.

Respectfully referred to Lieut. Col. H. M. Adams, Corps of Engineers, Division Engineer, Gulf Division.

It having been impracticable for the former division engineer to give this survey report consideration, it is desired that Lieutenant-Colonel Adams submit his views and recommendations in connection with the subject.

G. L. GILLESPIE,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Third indorsement.]

OFFICE DIVISION ENGINEER, GULF DIVISION,
New Orleans, La., December 4, 1901.

Respectfully returned to the Chief of Engineers, United States Army.

It is proposed in this report to construct a dike nearly 8 miles long, extending from the mainland near Texas City to the east end of Pelican Spit Flats, near Bolivar channel, at a cost of $2,250,000, and after this is constructed to close the entrance to West Bay, leaving an opening of 300 feet or less. If all the proposed works had been in place September 8, 1900, when the storm occurred, I think the city of Galveston would have been caught in a cul-de-sac and entirely drowned out. I notice that the dike is advocated—

First. To permit the closure of the entrance to West Bay.

Second. To develop Pelican Island and Pelican Spit for railway terminals.

Third. To make the harbor of Galveston a landlocked one.

Fourth. To maintain the "Texas City channel."

In my opinion, these reasons do not warrant the General Government in undertaking the work. I recommend that the plan be disapproved by the Chief of Engineers and Secretary of War. Nearly all of the water front of Galveston on the bay side is owned by the Galveston Wharf Company. Under the existing conditions the improvement of the inner harbor by dredging may properly be undertaken by the wharf company or by the city of Galveston.

H. M. ADAMS,
Lieut. Col., Corps of Engineers,
Division Engineer.

[Inclosure 1.]

REPORT OF MR. E. M. HARTRICK, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., January 24, 1901.

CAPTAIN: As per instructions, I have the honor to submit cross sections with estimate of cost of proposed dike to protect the inner harbor at Galveston, Tex.

The cross sections have been prepared after careful study of the conditions, and from personal experience at Galveston, its vicinity, and Gulf coast, during several cyclones and the late hurricane, with their accompanying high water and overflows. The manner of carrying on the work is based on the knowledge gained in the construction of Galveston jetties, and other jetties, breakwaters, and revetments in this district.

First will be taken up the order of construction, then the reasons for submitting such a method and cross section.

Order of construction.—Build a trestle and railway track from Texas City the whole length of dike, to be followed immediately by a wide brush mattress foundation, constructed and laid from the trestle, and at once cover with riprap. Through this mattress and covering of riprap drive sheet piles, not necessarily water-tight, but round piles driven as close together as practicable on the axis of the dike. Then, on this foundation erect a mound of quarry-run material, bringing it up in layers over the whole length of the dike, so that the currents will run evenly over the mound as it is built up.

Trestle and track.—Trestle and track has been found by experience far superior in handling material to that of floating plant, both on account of cost and rapidity of work. There is less loss of time from boisterous weather, less capital required, and greater earning capacity, the railways being able to forward material to the front in all weather. There are exceptions, but in this case the exceptions will be few. The only objection to its use in these waters is the action of the teredo navalis on the bearing piles of the trestle. The piles will have to be renewed about every two years, but it will be unnecessary to renew these piles if the money is available to push and complete the work within two years.

Brush mattresses.—For jetty work exposed to teredo navalis, tidal scour, and the strong storm currents of the Gulf, mattress foundation is, in my opinion, not advisable, as it deteriorates by erosion of the exposed ends, assisted by the worm, and has later to be replaced by stone. For closing a crevasse or the channel now under consideration a mattress foundation would seem the best, but care must be observed and prompt action taken to prevent scour at any particular point. It will also be in order about this time to take soundings to determine the tendencies of the deep curves of depth, so as to be prepared and prevent their too near approach to the toe of the dike. This protection can best be accomplished, as was done at Aransas Pass, by a revetment of riprap, which stopped the erosion on Mustang Island, where groins proved to be worthless and had to be abandoned. In this connection attention is called to the conditions that will exist at Galveston after the dike is constructed. They will be similar in many respects to Aransas Pass, varying only for Galveston in a greater width of channel, gorge, and depth of water. In addition there will be at Galveston an inner harbor, connected with the gorge by Galveston channel.

Bulkhead or sheet-piling curtain.—Some sort of curtain or apron is deemed necessary to prevent undermining of the dike from pressure caused from excessive head of water during strong northers or cyclones. At this time the dike will be subjected to forces and pressures similar to those that act on a dam. The brush mattress and stone mound might be adequate without reenforcement, and certainly would be if filling was available to make the dike and foundation impervious to water. The necessity of such reenforcement is well illustrated by the effect of water pressures and forces on the shore branch of south jetty, where the riprap of said branch, for economy, was laid directly on the sand, without any provision against undermining, The Gulf waters, having considerable head, percolated through and under the riprap of the shore branch, and, gaining strength, spouted up at the toe of the slope on the bay side, carrying the sand from under the riprap mound, scoured out holes into which the riprap was dropped and over which the waters of the Gulf rushed until equilibrium had been set up.

Stone mound.—A stone mound with brush-mattress foundation has been recommended on account of its being easily handled and controlled during construction, especially in crossing and closing Half Moon channel. An earth, sand, attenuated clay, or slush dike would have no stability in the Half Moon channel tideway, and would be difficult to retain until it was well above high water and the slopes protected with riprap. Such a dike might be advantageously constructed in the shoal waters, where the currents are weak, but is not recommended, on account of the unforeseen currents that may be developed during construction of dike.

Height of dike.—The crest of dike has been placed at 10 feeet above mean low tide, for the following reasons: The average height of water recorded on Galveston Island, either from bay or Gulf, previous to September 8, 1900, was 8 feet, with a maximum of 9½ feet reported by a few individuals. The late hurricane of September 8, 1900, shows a record of 14 feet above mean low tide, with a possible maximum of 16 feet. This great height of water came from the Gulf; but the waters of the bay are shoal and the reach is short, so the extreme height of water ought not to be taken into consideration in planning a protection for the city of Galveston during northers. In fact, a less height of dike might be advisable, to allow the waters of the Gulf, in times of hurricanes, an easy outlet, and thus reduce the possibility of a greater height of water and duration of flood over Galveston city.

Estimate of cost.

636,000 tons of riprap, at $2.25	$1,431,000
210,000 cubic yards of brush, at $1.70	357,000
43,330 linear feet of trestle and track, at $3	129,990
43,330 linear feet of piling, at $1.80	77,994
	1,995,984
Contingencies, engineering, superintendence, etc	254,016
Total	2,250,000

Very respectfully, your obedient servant,

E. M. HARTRICK,
Assistant Engineer.

Capt. C. S. RICHÉ,
Corps of Engineers, U. S. Army.

U 18.

ESTABLISHMENT OF HARBOR LINES IN LAVACA BAY, AT PORT LAVACA, TEXAS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., September 18, 1901.

GENERAL: In accordance with your telegraphic authority of August 30, 1901, I have the honor to submit the following report and recommendation regarding the establishment of harbor lines at Port Lavaca, Texas.

A survey of the locality was made on September 3 and 4, 1901, and a map[a] of same is herewith submitted. The proposed harbor lines and their description are shown thereon.

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[a] Not printed.

As the result of a visit to Port Lavaca, I ascertained that these harbor lines will be satisfactory to all interests affected. Deputy Collector Hirsch stated that these lines would be satisfactory to Collector Drake, who had previously made complaint regarding the unauthorized obstructions to navigation at Port Lavaca.

The proposed harbor lines are described as follows:

Beginning at mean low tide shore line of Lavaca Bay, at a point on the northerly prolongation of the west side line of South street, Port Lavaca, Tex.; thence about N. 43° 00′ E. magnetic, along the prolongation of said line to a point which is 1,044 feet from the intersection of said line with the axis of Guadalupe street.

Thence about N. 40° 28′ W. magnetic, about 3,642 feet to a point which is on the prolongation of the east-side line of Division street and 1,484 feet from the intersection of said line with the axis of Guadalupe street.

Thence about S. 43° 00′ W. magnetic, along said prolongation of the east side line of Division street to mean low-tide shore line of Lavaca Bay.

I have the honor to recommend that the harbor lines above described be approved and adopted.

Very respectfully, your obedient servant,

C. S. Riché,
Captain, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. Army.

[First indorsement.]

Office Chief of Engineers,
U. S. Army,
September 24, 1901.

Respectfully submitted to the Secretary of War.

It appearing that the establishment of harbor lines at Port Lavaca, Tex., is essential to the preservation of the harbor, Captain Riché, the district engineer officer, submits the accompanying tracing[a] on which is delineated and described the lines which in his opinion should be adopted.

I recommend that the lines selected be approved, and that the Secretary place his approval upon the tracing which has been prepared for his signature.

Jas. L. Lusk,
Acting Chief of Engineers.

[Second indorsement.]

War Department, *September 27, 1901.*

Approved as within recommended.

Wm. Cary Sanger,
Acting Secretary of War.

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[a] Not printed.

APPENDIX V

IMPROVEMENT OF CERTAIN RIVERS AND WATERWAYS IN LOUISIANA, TEXAS, ARKANSAS, AND MISSISSIPPI TRIBUTARY TO MISSISSIPPI RIVER.

REPORT OF CAPT. CHAS. L. POTTER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Red River, Louisiana, Arkansas, and Indian Territory.
2. Cypress Bayou, Texas and Louisiana.
3. Ouachita and Black rivers, Arkansas and Louisiana.
4. Bayou Bartholomew, Louisiana and Arkansas.
5. Boeuf River, Louisiana.
6. Tensas River and Bayou Maçon, Louisiana.
7. Mouth of Yazoo River and Harbor at Vicksburg, Mississippi.
8. Yazoo River, Mississippi.
9. Tallahatchie River, Mississippi.
10. Big Sunflower River, Mississippi.

SURVEY.

11. Ouachita and Black rivers, Arkansas and Louisiana.

United States Engineer Office,
Vicksburg, Miss., August 6, 1902.

General: I have the honor to transmit herewith annual reports for the fiscal year ending June 30, 1902, upon works of river and harbor improvement of the Vicksburg, Miss., district in my charge.

This district was in the charge of Maj. Thomas L. Casey, Corps of Engineers, until October 31, 1901, when I assumed temporary charge pursuant to Special Orders, No. 242, paragraph 25, dated Headquarters of the Army, Adjutant-General's Office, Washington, October 19, 1901.

Very respectfully, your obedient servant,

Chas. L. Potter,
Captain, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

V 1.

IMPROVEMENT OF RED RIVER, LOUISIANA, ARKANSAS, AND INDIAN TERRITORY.

Work for the general improvement of the river was continued during the fiscal year as follows:

The U. S. snag boat *C. W. Howell* was employed almost continuously, operations extending over the river below Shreveport, La., to the head of the Atchafalaya, a distance of 320½ miles. The boat was in command of Watkins Decker, except during a period of illness—July 2 to September 30, 1901—when James H. Britton was temporarily in charge.

The following is a summary of the work performed:

Snags pulled and destroyed	1,205
Stumps pulled, cut, and destroyed	387
Shore snags cut	549
Logs removed from channel	4
Side jams removed	20
Leaning trees felled	395
Trees girdled	674
Cubic yards of mud lump destroyed	37
Wreck removed (sunken flatboat at Elder Grove, La.)	1

The U. S. snag boat *O. G. Wagner*, Robert Elflein, master, was transferred from Black River to Lower Red River November 1, 1901, where it was employed until January 7, 1902. During this period it worked over the stretch between the head of Atchafalaya River and Poland Cut-off, 23 miles below Alexandria, La., and removed the following obstructions to navigation, viz:

Snags pulled	353
Stumps pulled, cut, and destroyed	1,514
Shore snags cut	712
Leaning trees felled	1,224
Logs cut up	50

In August, 1901, a party under the supervision of Overseer E. P. Allen was organized at Shreveport, La., and equipped with tools, tackle, explosives, etc., for work during the period of low water in the old raft region above Shreveport. Active operations commenced at Shreveport August 5, and from that date until October 31 were carried upstream 69 miles to the Louisiana and Arkansas line. From November 1 to December 27 the party worked back over the stretch to Shreveport. Channel snags and stumps, accumulations of drift, and logs that had lodged upon bars were destroyed as far as practicable. Shore snags, stumps, logs, and leaning timber along both banks were cut up or destroyed, and sliding and caving banks were cleared of trees and stumps.

The following is a summary of the work performed by this party, viz:

Channel snags destroyed	714
Channel stumps destroyed	329
Side jams removed	47
Logs cut up and destroyed	6,395
Stumps cut	1,738
Shore snags cut	22,331
Leaning trees felled	23,645
Trees girdled	43
Square yards of willows and brush cut	7,125
Wreck removed (part of steamer *John G. Fletcher*, sunk 1886, Shady Grove, La.)	1

* * * * * * *

With the funds available, it is proposed to continue snagging operations, etc., for the general improvement of the river from head of the Atchafalaya, Louisiana, to mouth of the Kiamichi, Indian Territory.

A survey of the locality will be made and report submitted respecting the provision of the act of June 13, 1902, that "$15,000 may, in the discretion of the Secretary of War, be spent in the improvement of the channel at Shreveport, La." Should additional work be found advisable, supplementary plans and recommendations will be submitted.

Money statement.

July 1, 1901, balance unexpended	$40,845.59
Amount appropriated by river and harbor act approved June 13, 1902	135,000.00
	175,845.59
June 30, 1902, amount expended during fiscal year	30,625.65
July 1, 1902, balance unexpended	145,219.94
July 1, 1902, outstanding liabilities	62.29
July 1, 1902, balance available	145,157.65
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	[a]
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

The appropriations for the early work, from 1828 to 1852, were as follows:

May 23, 1828	$25,000.00	March 3, 1841	$75,000.00
March 2, 1831	187.50	March 2, 1847	7,150.00
July 3, 1832	22,628.00	August 30, 1852	100,000.00
June 28, 1834	50,000.00		
March 3, 1835	50,000.00	Total	535,765.50
July 2, 1836	40,800.00	Amount expended	532,219.90
Do	30,000.00		
March 3, 1837	65,000.00		
April 20, 1838	70,000.00	Amount carried to surplus fund	3,545.60

The appropriations since 1872 have been as follows:

June 10, 1872	$20,000	July 5, 1884	$75,000
	150,000	August 5, 1886	75,000
March 3, 1873	80,000		7,000
June 23, 1874	50,000	August 11, 1888	65,000
March 3, 1875	20,000		35,000
August 14, 1876	35,000		3,000
April 10, 1869	4,500	September 19, 1890	100,000
February 7, 1878	6,000		28,000
June 18, 1878	24,000		2,000
	25,000	July 13, 1892	145,000
March 3, 1879	15,000		3,500
	22,500	August 18, 1894	150,000
	10,000		3,500
June 14, 1880	25,000	June 3, 1896	100,000
	60,000		3,000
	10,000	March 3, 1899	150,000
March 3, 1881	10,000	June 13, 1902	135,000
	10,000		
August 2, 1882	75,000	Total	1,732,000

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[a] Biennial appropriation should be $150,000.

COMMERCIAL STATISTICS.

Navigation of Red River above Montgomery to Shreveport, La., 158 miles, was suspended for about two and one-half months during the period of lowest water—from October 1 to December 15, 1901. Above Shreveport to Fulton, Ark., the river was navigable for light-draft steamboats, except during the above period of lowest water.

List of steamboats in the Red River trade during the fiscal year.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
						Light.	Loaded.			
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*			
Sunrise[a]	Stern-wheel.	473	186	36	6.5	2.5	8.1	New Orleans and Shreveport, La.	6	34
Electra	...do..	372	170	35	5.2	2.3	7.1	.....do	14	164
Alma	...do..	98	155	32	4	2	6	.....do	18	150
Red River	...do..	97	155	28	3.5	1.6	5	.....do	34	102
H. M. Carter	...do..	97	156	28	6	1.6	5	.....do	15	75
W. T. Scovell	...do..	244	160	31	3.7	2	5.1	.....do	11	72
G. W. Bolton	...do..	89	80.9	12.4	4.1	1.5	4	Alexandria and Pineville, La., ferry.		
City of St. Joseph	...do..							St. Louis, Mo., and Red River.	1	
Susie W	...do..	51	106.5	20	2.9	1.4	2.5	Shreveport, La., and local points.		
Lillie M. Barlow	...do..	46	119	18.2	2.6	1.5	3	Not reported		
Anna Tardy	...do..	71	81.2	18	4			.....do		
Kingfisher	...do..	27	74.6	16.1	2.5	1.8	3	Fulton, Ark., above and below.		
George L. Bass	...do..	53	91	21	3.3	2	3.7	Commerce and Alexandria, La.	34	
Gem	...do..	97	135	28	3.6	2	5.1	Shreveport and New Orleans, La. Shreveport, La., and Garland, Ark.	5 5	56 12
Luna	...do..	54				1.6	3.6	.....do	9	
George R. Marsh	...do..							Not reported		
Emma (gasoline)								.....do		
Julia H								.....do		
Mima								.....do		

[a] Burned at New Orleans, La., April 24, 1902.

Summary of commerce reported.

Articles.	1901-2.
	Tons.
Cotton	9,303
Cotton seed	6,309
Cotton-seed meal	3,194
Live stock	200
Hides and skins	100
Lumber	10,375
Saw logs	32,000
Staves	17,050
Miscellaneous	1,379
Total down freight	79,910
Return freight	9,309
Total	89,219
Estimated value	$3,194,000

In addition to the above is the commerce of Ouachita and Black rivers, which passes up and down Lower Red River. During the fiscal year 1901-2 this aggregated 313,863 tons, valued at $9,720,000, and the business of the past thirteen years ranges between 73,679 and 313,863 tons per annum, with values estimated at $3,293,000 to $10,234,250, the average of the thirteen years being 172,346 tons, valued at $6,394,750.

Receipts and shipments of bales of cotton at Shreveport, La.

	1901-2.
RECEIPTS.	
By rail	(a)
By wagon	(a)
By river	(a)
Warehouse receipts	212,954
SHIPMENTS.	
By Texas and Pacific Rwy	(a)
By Vicksburg, Shreveport and Pacific Rwy	(a)
By Houston and Shreveport R. R	(a)
By St. Louis Southwestern Rwy	(a)
By Kansas City Southern Rwy	(a)
By Shreveport and Red River Valley Rwy	(a)
By Texarkana, Shreveport and Natchez Rwy	(a)
By Missouri, Kansas and Texas Rwy	(a)
By river to New Orleans	(a)
Total	214,430

[a] Details not furnished.

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[For railroads, see report for 1901.]

V 2.

IMPROVEMENT OF CYPRESS BAYOU, TEXAS AND LOUISIANA.

No work was done, as there was no stage during the fiscal year on which the United States dredge, waiting at Shreveport, La., since July 5, 1897, could cross Albany Flats and enter the lakes. Reference is invited to the Report of the Chief of Engineers for 1898 (pp. 1589 to 1593) upon this subject. The highest reading of the Shreveport gauge during the year was 17.6 feet, June 13-15, 1902.

The expenditures made during the year were for care of the dredge at Shreveport.

The expenditure of the available funds for dredging, or for the removal of snags, stumps, etc., will afford no improvement to navigation between Shreveport and Jefferson, and it is recommended that the project be repealed and the funds paid into the Treasury.

Money statement.

July 1, 1901, balance unexpended	$5,735.36
June 30, 1902, amount expended during fiscal year	933.10
July 1, 1902, balance unexpended	4,802.26

The appropriations for Cypress Bayou and the lakes have been as follows:

By act of—

June 10, 1872	$10,000.00
March 3, 1873	50,000.00
August 14, 1876	13,000.00
June 18, 1878	15,000.00
March 3, 1879	6,000.00
August 5, 1886	18,000.00
August 11, 1888 (allotted from appropriation for Red River)	5,000.00
September 19, 1890, for survey	10,000.00
July 13, 1892, for survey	2,000.00
July 13, 1892 (allotted from appropriation for Red River)	1,701.33
August 18, 1894	10,000.00
June 3, 1896	5,000.00
Total	145,701.33

COMMERCIAL STATISTICS.

There was no navigation between Shreveport and Jefferson during the year.

V 3.

IMPROVEMENT OF OUACHITA AND BLACK RIVERS, ARKANSAS AND LOUISIANA.

The U. S. snag boat *O. G. Wagner*, Robert Elflein, master, was employed from July 1 to October 31, 1901, between Sinope Landing and the mouth of Black River, Louisiana, a stretch of 139 miles. The boat was transferred to the improvement of Red River November 1, but returned to Black River January 7, and between that date and March 5, 1902, worked upstream to Camden, Ark., and thence back to Monroe, La., where it was laid up.

The following is a summary of the work performed by the *Wagner* during the above periods, viz:

Snags pulled	600
Stumps pulled, cut, and destroyed	1,994
Shore snags cut	1,843
Leaning trees felled	9,167
Trees girdled	1,561

Wrecks removed, viz: Parts of steamboats *C. A. Hill* (sunk 1899) and *Ruby* (burned October, 1901) opposite Trinity, La.

March 9 to 20, 1902, accompanied by Assistant Engineers H. M. Marshall and John Ewens, I made an inspection trip on the snag boat *Columbia* from the mouth of Black River, Louisiana, to Camden, Ark., 350 miles, and also inspected the following tributary streams on the way up, viz: Little River and Catahoula Lake, Tensas River and Bayou Maçon, Boeuf River, Bayou D'Arbonne, and Bayou Bartholomew.

SURVEY.

Office and field work of the survey were continued during the year, and a final report thereon was submitted February 22, 1902 (printed in House Doc. No. 448, Fifty-seventh Congress, first session, and republished in the Report of the Chief of Engineers for 1902, p. 1435). Since then work upon the maps and notes has continued. For details, reference is invited to the report of Assistant Engineer Marshall, appended hereto.

With the funds available it is proposed to continue snagging operations, etc., for maintenance of the improvement from mouth of Black River to Camden; to complete the survey for locks and dams, and to acquire the sites and commence the construction of two locks and dams, one near Monroe, La., known as Lock 4, and one near Roland Raft, Ark., known as Lock 6.

River and harbor act approved June 13, 1902, provides—

> That a contract or contracts may be entered into by the Secretary of War for such materials and work as may be necessary to complete the work of constructing said locks and dams, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate $353,954, exclusive of the amounts herein and heretofore appropriated.

The chief item of the following estimate for the fiscal year ending June 30, 1904, is based upon the above provision:

Completing locks and dams Nos. 4 and 6	$353,954
Rebuilding snag boat *O. G. Wagner*	25,000
Maintenance of work from mouth of Black River, Louisiana, to Camden, Ark	20,000
Total	398,954

Respecting the need for rebuilding the snag boat *O. G. Wagner*, reference is invited to Major Casey's report of last year. (Report Chief of Engineers 1901, pp. 2035–2036.)

Money statement.

July 1, 1901, balance unexpended		$31,889.32
Amount appropriated by river and harbor act approved June 13, 1902		111,500.00
		143,389.32
June 30, 1902, amount expended during fiscal year		25,191.51
July 1, 1902, balance unexpended		118,197.81
July 1, 1902, outstanding liabilities		322.24
July 1, 1902, balance available		117,875.57
Amount (estimated) required for completion of existing project		1,918,576.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$353,954.00	
For rebuilding snag boat	25,000.00	
For maintenance of improvement[a]	20,000.00	
		398,954.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

The appropriations have been as follows:

By act of—	
Mar. 3, 1871	$25,000
Do	26,000
June 10, 1872	60,000
Do	40,000
Mar. 3, 1873	60,000
Aug. 14, 1876	12,000
June 18, 1878	10,000
Mar. 3, 1879	10,000
June 14, 1880	8,000
Mar. 3, 1881	12,000
Aug. 2, 1882	12,000
July 5, 1884	15,000

By act of—	
Aug. 5, 1886	$17,500
Aug. 11, 1888	20,000
Sept. 19, 1890	15,000
July 13, 1892	40,000
Aug. 18, 1894	50,000
June 3, 1896	70,000
Mar. 3, 1899	110,000
June 13, 1902	31,500
Do	80,000
Total	724,000

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[a] Biennial appropriation should be $40,000.

COMMERCIAL STATISTICS.

During the fiscal year 1902 Ouachita and Black rivers were reported navigable for New Orleans packets to Camden, Ark., from December to June. At lowest stages the New Orleans boats could not ascend above Harrisonburg, La. Small light-draft boats that ply in the tributaries could run the main river nearly the whole year.

List of steamboats engaged in the trade during the fiscal year.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
						Light.	Loaded.			
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*			
America	Stern-wheel.	427	200	38	6.5	4	11.3	New Orleans and Monroe, La.	21	2,228
City of Camden	do	299	175	35	5	2.5	5.5	New Orleans, La., and Camden, Ark.	7	530
								New Orleans, La., and Wilmington, Ark.	1	......
								New Orleans, La., and English Bee, Ark.	1	......
Ouachita	do	98	140	32	4	......	......	New Orleans and Columbia, La.	8	......
								New Orleans and Harrisonburg, La.	6	370
Fred A. Blanks	do	457	189	38	6.5	3.5	10	New Orleans and Monroe, La.	16	986
Red River	do	97	155	28	3.5	1.6	5	do	10	142
Parlor City	do	136	125	26	3.7	2.5	5.5	do	20	392
								Monroe, La., and Champagnolle, Ark.	18	443
								Monroe, La., and local points.	1	......
								Monroe, La., and Boeuf River.	1	......
								Monroe, La., and Bayou Bartholomew.	3	......
Will Davis[a]	do	150	100.8	23.6	3.6	1.7	2.2	New Orleans and Catahoula Lake, La.	15	......
Lillie[a]	do	61	120	26	3.5	2	4	Jonesville and Tensas River, La.	......	......
								Jonesville and Little River, La.	104	......
								Jonesville and Red River, La.	25	......
City of Peoria	do	128	130	26	4.5	......	......	Monroe and Lake	2	......
								Monroe and Boeuf River, La.	3	......
John B. Robinson	do	43	90	18	3.5	1.4	3	Monroe and Bayou Bartholomew.	15	......
								Monroe and local points.	10	......
May Fisher[a]	do	52	92	18.8	4	2	2	Baton Rouge and Ouachita River.	3	......
Pearlie Davis[a]	do	140	127	26	4	......	......	New Orleans and Ouachita River.	2	......
Dixie[a]	....	71	119.1	20.6	3.8	......	......	do	1	......
Sam Atlee[a]	do	234	133.3	26.3	4	......	......	Baton Rouge and Jonesville, La.	2	......
								New Orleans and Alabama Landing, La.	1	......
Jennie Gilchrist[a]	do	74	100.5	18.5	3.8	......	......	Not reported	......	......
Osceola	do	24	70.6	15.2	2.9	1	2.5	Jonesville and Tensas River, La.	20	......
Lee Otis[b]	Tug	4.5	40	9	5	4.5	4.5	Stafford and Alto, La.	13	......
Florence Swayze	do	5	......	......	......	3	3	Not reported	......	......
Alarm[a]	**Stern-wheel.**	**189**	**142**	**26**	4.3	3.4	4.4	**New Orleans and Ouachita River.**	**2**	......
Belle Prince[a]	**do**	**109**	**114.4**	**19.6**	**3.6**	......	......	**Not reported**	......	......
Daisy[a]	**do**	**33**	**60.1**	**13.4**	**5.4**	......	......	**do**	......	......

[a] **Towboat.**

[b] **With one or more barges.**

List of steamboats engaged in the trade during the fiscal year—Continued.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
						Light.	Loaded.			
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*			
R. J. Wheeler[a]	Stern-wheel.	140	126	26.2	3.9	......	......	New Orleans and Ouachita River.	3	......
Ike[b]	....do	66	57.7	18.2	2.6	......	......	Not reported	......	......
L. Knight[b]	......	......	......	......	......	......	......	....do	......	......
Phil Davis[a]	Stern-wheel.	94	96.4	22.8	2.8	......	......	....do	......	......
C. B. Bryan[a]	....do	96	114.2	29	4.5	2.6	4	New Orleans and Ouachita River.	1	......
Dewey[b]	Tug	3	......	......	......	4	5	Local towing near Trinity, La.	......	......
Skipper	....do	......	......	......	......	......	......	Towing for sawmills at Monroe, La.	......	......
Wayzata	....do	6	33	7	3.7	1.9	2.2	....do	......	......
T. K. Green[c]	Stern-wheel.	32	81.8	17.3	3.1	1.5	2.5	Jonesville and Bayou D'Arbonne, La.	1	......
Alert	Gasoline.	6	......	......	......	1	2.4	Monroe and Farmerville, La.	8	50
Freddie Wall	....do	10	......	......	......	1.6	2.4	....do	25	200
Palmer	....do	......	......	......	......	......	......	Monroe and Bayou D'Arbonne, La.	......	......
Union	....do	......	......	......	......	1.4	3	Monroe and vicinity	......	30
J. W. Swayze	Stern-wheel.	86	110	21	3.7	1.7	4	Jonesville and Little River, La.	56	......
								Jonesville and Tensas River, La.	56	......
								Stafford and Alto, La., Boeuf River.	26	......

[a] Towboat. [b] With one or more barges. [c] Sunk in Bayou D'Arbonne.

Summary of commerce reported.

Articles.	1901-2.
	Tons.
Cotton	20,734
Cotton seed	15,851
Hides and skins	9
Live stock	159
Lumber	2,723
Saw logs	180,000
Staves	65,000
Miscellaneous	10,150
Total down freight	294,626
Return freight	19,237
Total	313,863
Estimated value	$9,720,000

Receipts and shipments of bales of cotton at Monroe, La.

Route.	1901-2.	
	Received.	Shipped.
Vicksburg, Shreveport and Pacific Rwy	13,477	21,509
Missouri Pacific Rwy	27,621	33,505
River	3,208	4,153
Wagon	19,205	....
Total	63,511	59,167

Receipts and shipments of bales of cotton at Camden, Ark.

Route.	1901-2.	
	Received.	Shipped.
Missouri Pacific Rwy	1,653	9,826
St. Louis Southwestern Rwy	1,080	1,663
River	2,108	16,983
Wagon	24,336	....
Total	29,177	28,472

[For railroads, see report for 1901.]

REPORT OF MR. H. M. MARSHALL, ASSISTANT ENGINEER.

United States Engineer Office,
Vicksburg, Miss., June 10, 1902.

Captain: I have the honor to submit the following report on survey of Ouachita and Black rivers, Arkansas and Louisiana, for the last fiscal year.

The boring party, under Surveyor William R. Neely, made borings in the vicinity of Riverton during July. No very satisfactory location was found, but the material near Upper Breston was fairly good. Trouble there with the land owner in regard to survey lines, which compelled cutting a row of corn, the yield from which would probably have been a couple of bushels and for which damages and court costs amounting to $32.15 were assessed, gave sufficient intimation of what was in store if that place should be selected for a lock and dam site. Low water put a stop to operations, and the party was disbanded.

In October boring was resumed and trial made at Calls Landing, about a mile above Upper Breston. A fair foundation was found and that site was chosen. The party moved down on Black River to ascertain if any suitable location existed above New Hope. Borings were made at two places, but nothing save sand was found. The party then moved back to Catahoula shoals and made a boring about 200 feet deep. Strata of clay and rock were found to a depth of 158 feet, and then white sand, affording a free flow of clear, soft water. No other work was done in the field during the year.

In the office all field notes were checked and indexed, and general indexes were prepared of all, except topography and hypsometry, which are not quite complete. Maps of all surveys have been finished except 4 of the tracings of the Bayou Bartholomew sheets and the local surveys of the lock sites. The map sheets on Ouachita and some of the tributaries were plotted on tracing linen in order that blue-prints might be made without extra cost, but it has proved to be a poor economy. The sheets have become soiled, stretched in some directions and shrunken in others, till they are not a fit representation of a high-class survey. The chain line should be replotted on heavy drawing paper and the tracings transferred by pantograph and made to fit the correct line.

Final report, with plan for locks and dams, was completed and submitted in February. It was published in House Doc. No. 448, Fifty-seventh Congress, first session, and contained all data collected during the survey.

Two locks and dams having been provided for in the river and harbor bill which has passed the Senate and House, the estimates and specifications necessary for advertising and letting the contract are now in course of preparation.

Very respectfully, your obedient servant,

H. M. Marshall,
Assistant Engineer.

Capt. Charles L. Potter,
Corps of Engineers

V 4.

IMPROVEMENT OF BAYOU BARTHOLOMEW, LOUISIANA AND ARKANSAS.

No work was done during the fiscal year for the maintenance of this improvement, the balance available being too small to permit of the organization and equipment of a special party for the purpose. The expenditures made were for the care and preservation of plant used upon the work.

The river and harbor act of June 13, 1902, appropriated $15,000 for maintenance of the improvement of Bayou Bartholomew and of five other tributaries of Ouachita River. It is proposed to apply the allotment for Bayou Bartholomew to the removal of obstructions between its mouth and McComb Landing, Ark., during the period of low water.

The annual cost of maintaining the work in Bayou Bartholomew was estimated to be $2,500. Drift, sliding and caving banks, and the rapid growth of vegetation constantly add new obstructions, which, if allowed to remain, accumulate more rapidly and become more difficult to remove each year.

Money statement.

July 1, 1901, balance unexpended	$785.09
Allotment from amount appropriated by river and harbor act approved June 13, 1902, for various tributaries of Ouachita River [a]	5,000.00
	5,785.09
June 30, 1902, amount expended during fiscal year	281.94
July 1, 1902, balance unexpended	5,503.15
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	([b])

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

The appropriations have been as follows:

By act of—		By act of—	
March 3, 1881	$8,000	August 18, 1894	$5.000
August 2, 1882	5,000	June 3, 1896	4,000
July 5, 1884	5,000	March 3, 1899	5,000
August 5, 1886	5,000	June 13, 1902 (allotment)	5,000
August 11, 1888	5,000		
September 19, 1890	5,000	Total	57,000
July 13, 1892	5,000		

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[a] This appropriation was allotted as follows:

For maintenance of improvement of—

Bayou Bartholomew, Louisiana, and Arkansas	$5,000
Bœuf River, Louisiana	5,000
Tensas River and Bayou Maçon, Louisiana	2,500
Bayous d'Arbonne and Corney, Louisiana	2,500
Amount of appropriation	15,000

[b] Biennial appropriation should be $5,000.

COMMERCIAL STATISTICS.

In the past fiscal year Bayou Bartholomew was reported to have been navigable from January 15 to June 30, 1902.

List of stern-wheel steamboats engaged in navigation during the year.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.
					Light.	Loaded.		
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*		
Parlor City	136	125	26	3.7	2.5	5.5	Monroe and Bayou Bartholomew.	3
John B. Robinson	43	90	18	3.5	1	2.5	Not reported	
Palmer (gasoline)							do	
Freddie Wall (gasoline)	10				1.6	2.4	do	

Summary of commerce reported.

Articles.	1901-2.[a]
	Tons.
Cotton	200
Cotton seed	400
Saw logs	12,000
Staves	50
Miscellaneous	165
Total down freight	12,815
Return freight	600
Total	13,415
Estimated value	$198,000

[a] Incomplete. Three small steamers that ply in the bayon failed to furnish information of freights carried.

* * * * * * *

V 5.

IMPROVEMENT OF BŒUF RIVER, LOUISIANA.

Work for the maintenance of this improvement was resumed at Point Jefferson May 6, 1901, and on June 30, 1901, had been carried downstream 65 miles to near Tanglewood, La. (See Report of the Chief of Engineers, 1901, p. 2044.) From July 1 to September 2, 1901, operations were continued downstream to the mouth, a distance of 86 miles, under the local supervision of Overseer J. R. Vaughan. The stages were near extreme low water during the entire period, and the obstructions were destroyed to and below the water surface, affording safe navigation for the time at any stage upon which steamboats can run.

The following is a summary of the work performed, viz:

Channel snags cut and destroyed	2,887
Stumps cut and destroyed	1,479
Shore snags cut and destroyed	1,595
Logs removed from channel	711
Logs cut and destroyed along the banks	3,704
Trees felled and destroyed	1,089
Trees removed from channel	7
Square yards of willows and brush cleared	24,437

After completion of this work the force and outfit were transferred to Bayou Maçon.

The three outlets of Bœuf River near Point Jefferson, Louisiana, have been open since the flood of 1890, and as no provision for their closure has been made in the twelve years, it appears reasonable to assume that it is not the intention of Congress to enter upon that part of the project which contemplates rebuilding the dams and connecting levees. It is proposed, therefore, to apply the unexpended balance of former appropriations to maintenance of the work performed for the removal of snags, logs, leaning timber, etc., obstructing navigation between the mouth and Wallace Landing, Louisiana. The estimate for closing outlets is omitted from the money statement below, and the unexpended balance probably will be sufficient for maintenance of the improvement to June 30, 1904.

Money statement.

July 1, 1901, balance unexpended	$9,848.84
Allotment from amount appropriated by river and harbor act approved June 13, 1902, for various tributaries of Ouachita River,	5,000.00
	14,848.84
June 30, 1902, amount expended during fiscal year	2,848.84
July 1, 1902, balance unexpended	12,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	([a])
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

The following appropriations have been made:

By act of—		By act of—	
March 3, 1881	$5,000	August 18, 1894	$8,000
August 2, 1882	5,000	June 3, 1896	6,000
July 5, 1884	5,000	March 3, 1899	6,000
August 5, 1886	5,000	June 13, 1902 (allotment)	5,000
August 11, 1888	6,000		
September 19, 1890	5,000	Total	66,000
July 13, 1892	10,000		

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[a] Biennial appropriation should be $5,000.

COMMERCIAL STATISTICS.

In the fiscal year Bœuf River was reported to have been navigable from January 1 to June 30.

List of steamboats engaged in navigation during the fiscal year.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between	Round trips.
						Light.	Loaded.		
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*		
Parlor City	Stern-wheel.	136	125	26	3.7	2.5	5.5	Monroe and Bœuf River, Louisiana.	1
City of Peoria	do	128	130	26	4.5			do	3
Lillie[a]	do	61	120	26	3.5	2	4	Jonesville and Bœuf River, Louisiana.	3
J. W. Swayze	do	86	110	21	3.7	1.7	4	Stafford and Alto, La	26
Lee Otis[b]	Tug	4.5	40	9	5	4.5	4.5	do	13
Florence Swayze[b]	do	5				3	3	Stafford and Bœuf River, Louisiana.	
Dewey[b]	do	3				4	5	Jonesville and Boeuf River, Louisiana.	

[a] Towboat. [b] With barges.

Summary of commerce reported.

Articles.	1901-2.
	Tons.
Cotton	885
Cotton seed	2,315
Hides and skins	2
Live stock	4
Lumber	200
Saw logs	100
Staves	2,804
Miscellaneous	208
Total down freight	6,518
Return freight	382
Total	6,895
Estimated value	$300,000

The Vickburg, Shreveport and Pacific Railway crosses Bœuf River near Girard, La., and the New Orleans and Northwestern Railway crosses about 2 miles north of Rayville, La. The Houston, Central Arkansas and Northern Railroad runs parallel to the river on the west.

V 6.

IMPROVEMENT OF TENSAS RIVER AND BAYOU MAÇON, LOUISIANA.

After suspending work in Bœuf River, Louisiana, an outfit of tools, tackle, tents, cooking range, utensils, etc., was shipped to Delhi, La., preparatory to resuming work for the improvement of Bayou Maçon. A barge (18¾ by 57¼ feet) was hired for quarters of employees, and for storage and transportation of tools and stores, and after placing the outfit aboard it was moved from Delhi upstream to Floyd, where active operations commenced.

From September 27 to December 21, 1901, work was carried from Floyd to the mouth of Bayou Maçon, 111.5 miles, and thence down Tensas River to its mouth, 42.7 miles, under the supervision of Overseer J. R. Vaughan. Continued low water facilitated operations. The stretches worked over were put in safe navigable condition, the following obstructions having been destroyed:

Channel snags cut and destroyed	2,549
Stumps cut and destroyed	3,077
Shore snags cut and destroyed	1,349
Jams removed	1
Side jams removed	1
Logs removed from channel	372
Logs cut and destroyed along the banks	1,820
Trees removed from channel	68
Leaning trees felled and destroyed	1,313
Square yards of willows and brush cleared	38,639
Cubic yards of mud lumps removed from channel	8
Wreck removed	1

(Towboat *Cleon*, burned 1900, about 1 mile above Egypt Landing, Bayou Maçon.)

With the funds available for maintenance of this improvement, it is proposed to work over Tensas River to Westwood Place, about 75 miles above the mouth, and up Bayou Maçon to Floyd, to remove and destroy obstructions to navigation added since operations were suspended.

Money statement.

July 1, 1901, balance unexpended	$4,137.56
Allotment from amount appropriated by river and harbor act approved June 13, 1902, for various tributaries of Ouachita River	2,500.00
	6,637.56
June 30, 1902, amount expended during fiscal year	3,899.65
July 1, 1902, balance unexpended	2,737.91
July 1, 1902, outstanding liabilities	39.24
July 1, 1902, balance available	2,698.67
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	[a]2,500.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

The appropriations have been as follows:

By act of—		By act of—	
March 3, 1881	$3,000	August 18, 1894	$5,000
July 5, 1884	4,000	June 3, 1896	5,000
August 5, 1886	4,000	March 3, 1899	4,000
August 11, 1888	5,000	June 13, 1902 (allotment)	2,500
September 19, 1890	5,000		
July 13, 1892	5,000	Total	42,500

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[a] Biennial appropriation should be $5,000.

COMMERCIAL STATISTICS.

During the fiscal year Bayou Maçon was reported to have been navigable from February 1 to May 15. Lower Tensas River was navigable somewhat longer, but the period of low water in both streams was unusually protracted.

List of steamboats engaged in navigation during the fiscal year.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.
						Light.	Loaded.		
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*		
J. W. Swayze	Stern-wheel.	86	110	21	3.7	1.7	4	Jonesville and Tensas River, Louisiana.	56
Osceola	do	24	70.6	15.2	2.9	1	2.5	do	20
Bettie Lee	do	28	56	12	2.5	1	3	Delhi and Lane Ferry, Louisiana Delhi and Floyd, La Delhi and Crockett Point, Louisiana	10 10 5
Lillie[a]	do	61	120	26	3.5	2	4	Jonesville, Tensas River, and Bayou Maçon, Louisiana.	(b)
Dewey[c]	Tug	3				4	5	Jonesville and Tensas River, Louisiana.	(b)

[a] Towboat. [b] Not reported. [c] With barges.

Summary of commerce reported.

Articles.	1901-2.
	Tons.
Cotton	2,686
Cotton seed	7,766
Hides and skins	1
Live stock	6
Staves	3,220
Lumber	1,122
Miscellaneous	110
Saw logs	156
Total down freight	15,067
Return freight	871
Total	15,938
Estimated value	$428,000

The Vicksburg, Shreveport and Pacific Railway crosses Bayou Maçon near Delhi, and Tensas River near Dallas, La. The New Orleans and Northwestern Railway crosses Tensas River at Clayton, Concordia Parish, La.

V 7.

IMPROVEMENT OF MOUTH OF YAZOO RIVER AND HARBOR AT VICKSBURG, MISSISSIPPI.

The Atlantic, Gulf and Pacific Company, contractors for the work of excavation along the diversion route from Old River to Kleinston Landing, continued operations during the year, without cessation, using the three dredges described in last year's report. (Report Chief of Engineers, 1901, p. 2063.)

The condition of the work at the close of the fiscal year ending June 30, 1902, was as follows:

The quantities of excavation since operations under the contract commenced, as measured for monthly payments, have been as follows:

	Cubic yards.
November 19, 1900, to June 30, 1901	1,871,764
July 1, 1901, to June 30, 1902	2,823,015
Total work on which payments have been made	4,694,779
Excavation on which payment is withheld until conpletion of contract	11,341
Total work performed to June 30, 1902	4,706,120
Approximate quantity required to complete contract	918,880±
Total	5,625,000±

For details and general information respecting the work, reference is invited to the appended report of Mr. T. C. Thomas, assistant engineer, in local charge.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$776,998.25
June 30, 1902, amount expended during fiscal year	375,490.97
July 1, 1902, balance unexpended	401,507.28
July 1, 1902, outstanding liabilities	11,535.87
July 1, 1902, balance available	389,971.41
July 1, 1902, amount covered by uncompleted contracts	115,347.40

LIST OF APPROPRIATIONS MADE.

July 13, 1892	$75,000
August 18, 1894	225,000
Do	40,000
June 4, 1897	350,000
March 3, 1901	510,000
Total	1,200,000

ABSTRACT OF CONTRACT IN FORCE.

Name of contractor.	Rate per cubic yard.	Date of approval.	Date of beginning work.	Date of expiration.
Atlantic, Gulf and Pacific Co	*Cents.* 12.4	Aug. 10, 1900	Nov. 19, 1900	May 19, 1903

COMMERCIAL STATISTICS.

For commercial statistics see Yazoo River and its tributaries.

REPORT OF MR. T. C. THOMAS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., June 30, 1902.

CAPTAIN: I have the honor to submit report on survey and dredging operations in the Yazoo River diversion canal during the fiscal year ending June 30, 1902.

A force of four men, under Junior Engineer L. L. Griffith, was retained for sounding after the dredges, maintaining gauges, etc. In addition to this routine work, the following surveys were made as opportunity offered: In July, 1901, a survey was made of the east branch of Lake Centennial from the south end of open water in lake to the head of De Soto Island. On the south this survey overlaps one made in April, 1900, covering the harbor division of the canal and extending north to Glass Bayou. For the 1901 survey sounding ranges were laid off at about 300-foot intervals, from a taped base on the east bank of lake, and individual soundings were located by sextant angles and range. Later a similar survey was made of the Wrong End of Old River, from the head of the "main cut" of canal to the Yazoo River. Sounding ranges were laid off at about 300-foot intervals until the limits of probable excavation were passed, then at greater distances. These surveys were plotted to a large scale, foot contours laid down, and a paper location made of the corresponding stretches of canal.

Immediately after the high water of 1901-2 a survey was made, by the same general methods, at the present mouth of the Yazoo, and extending from below the foot of towhead at mouth up to deep water in the Yazoo proper.

In November, 1901, when the river stage was low, the harbor division of canal was cross-sectioned from the Mississippi River to the head of the channel dredged in 1900-1901, and the cross ranges sounded immediately after the recession of the high water of 1900-1901. In December and January the whole area dredged over in the "main cut" was sounded at whole and half ranges, to acquire data for determining natural fill in that part of canal in the event of a general overflow.

In May surveys were run and estimates made for a levee from mouth of canal to east end of the Lake Centennial dam; and for an alternative levee along the left bank of the Mississippi River from mouth of canal to Kings Point. Special reports on these levees have been submitted. In same month the stretch of canal in Old River was located in the field, from a taped base on east bank of river. The sloping bank was covered with timber and underbrush extending out into the water, and an extra force of laborers had to be employed to clear the cross ranges in time for the dredging. During the high-water period, April and latter part of March, the survey party was in constant attendance on the dredges, soundings being taken immediately before and behind those working in the harbor division, to determine the fill due to the inward current in canal. A considerable number of the posts marking the canal stations were broken down by rafts drifting in the Lake Centennial pool, by the contractors' mud scows and barges, and by the swinging cables of the hydraulic dredges. These were replaced by the survey party at odd times. The cross ranges of canal were also kept cleared of weeds and bushes beyond the limits of excavation, for convenience in stretching the sounding cable between the side monuments of canal.

In February a new estimate was made for canal, based on the following plan: Grade to start at 44 feet, mean Gulf level, in Old River and terminate at 38 feet, mean Gulf level, at mouth of canal. This is 6.57 feet below average low water in Wrong End of Old River, and 6.27 feet below the average low water in the Mississippi River at mouth of canal for the eleven-year period 1891 to 1901. The total fall of 6 feet Old River to mouth of canal is uniformly distributed through the "main cut" Old River to Lake Centennial, and through the cut from deep water in Lake Centennial to the Mississippi River. No slope is provided for in the stretches of canal lying in Old River and in Lake Centennial. The cross section was to consist of an upper cut 220 feet wide at bottom in all recent deposits and 190 feet wide at bottom for all old formations, and extending from natural ground surface—or from bottom of channel as already excavated—to within 16 feet of grade; and of a lower cut 80 feet wide at bottom, and extending from grade to bottom of upper cut. All side slopes to be 1¼:1. The object of this cross section was to provide a channel wide enough to guard against choking up by sloughing banks and deep enough to afford free ingress of the Yazoo River at the lowest stages of that stream.

The contraction of the cross section at bottom is designed to give a fair velocity for the minimum discharge through the canal, and thus promote natural scour. For the last 1,000 feet of "main cut" the upper cut is 190 feet wide at bottom and has side slopes of 3:1. This special cross section was adopted here because the upper part of the canal prism had already been excavated according to the old cross section, to within the above distance of Old River, and it was thought inadvisable to introduce a contraction at the point of ingress from Old River. This change of plan reduced the originally estimated yardage 25 per cent, the amount allowed by the contract under which the work is being executed.

DREDGING.

At beginning of fiscal year the clam shell was working in the low ground between open water of lake and the main bank, and the hydraulic dredges were located between the main bank of Lake Centennial and Barnett Lake, all dredges being in the "main cut" of canal. During the year the clam shell has operated from the initial point of the main cut, in open water of Lake Centennial, westward to Barnett Lake, deepening the channel made by the hydraulics. The hydraulics dug westward, making a shallow cut practically the whole width of canal until within 2,000 feet of Barnett Lake, thence to lake they deepened the single cut made on left side of canal by dredge No. 5 in May, 1901. This channel was dug to give access to Barnett Lake and the part of canal lying still farther to the west, and it was made only of such width and depth as would insure safe communication with the Lake Centennial pool. The object of this arrangement of the work was to keep the hydraulic dredges employed in places remote from the Lake Centennial dam, or in material not suitable for the dam, such as that found in the bed of Barnett Lake. On reaching Barnett Lake the dredges began cutting the full width of canal, going down to 15 feet on the Kleinston gauge. This cut has been carried forward, without material change, to within 50 feet of the top bank of Old River. In February and March, 1902, a bottom cut was made through Barnett Lake and 700 feet farther west, going down practically to grade. In February the narrow cut on the east of Barnett Lake was widened for a distance of 700 feet, and a bottom cut, reaching grade, was made over the same stretch. The bottom cut beyond the limits of Barnett Lake was made hydraulically, to raise the training dike across the south branch of the lake, and immediately to the west of lake.

On completion of the work in and near Barnett Lake, the river stage was such as to permit the passage of the dredges over the impounding dikes, and they returned to the harbor division of canal, dredge No. 5 coming out of the pool on March 21, and No. 4 on April 11. Dredge No. 5 widened the narrow channel excavated in 1900-1901 from the mouth to a point 1,800 feet in; then made a bottom cut from mouth to station No. 21½, 3,500 feet in, excavation being carried to grade. Dredge No. 4 worked northward from the head of channel dredged in 1900-1901, carrying a superficial cut as far as the impounding dike at Jackson street; then dug southward from the elevator, taking out the bottom cut to grade. On May 23 dredge No. 4 was taken to Wrong End of Old River, and on the 24th began excavating the stretch of canal lying in the shallow part of that stream. A single cut was made from toe of river bank, head of "main cut" northward to intersection of grade with natural bottom of river, a distance of 5,000 feet. On completing this work, June 8, the dredge returned to the harbor division and began excavation of the bottom cut from elevator to Jackson street dike, going down to grade.

The net result of excavation under present contract, at end of fiscal year, is roughly as follows: The "upper cut" has been taken out for the whole canal except for narrow strips at the Jackson street dike and at head of "main cut," left to maintain the Lake Centennial pool, and for the stretch in east branch of Lake Centennial where no dredging has been done. The "lower cut" has been excavated practically throughout the harbor division of canal; from deep water in north end of Lake Centennial to a point about 2,500 feet west of the main bank of that lake, except for a stretch of about 2,000 feet lying in the willow flat east of that bank; through Barnett Lake and for distances of about 700 feet on the east and on the west of that lake, and from the toe of the bank of Old River, at head of the main cut, out to deep water in that river.

TABLE I.—*Statement of excavation by localities.*

Limiting localities.	Excavation during fiscal year.		Total.
	1901.	1902.	
	Cubic yds.	*Cubic yds.*	*Cubic yds.*
Mississippi River to Jackson street dike	1,026,743	470,881	1,497,624
Deep water in Lake Centennial to Barnett Lake, east end	845,021	802,532	1,647,553
Barnett Lake, east to west end		713,927	713,927
West end Barnett Lake to bank of Old River		744,717	744,717
Bank of Old River to deep water in Old River		102,299	102,299
Total	1,871,764	2,834,356	4,706,120

Total yardage by estimate of 1902	5,652,212
Total yardage excavated at end of fiscal year	4,706,120
Total yardage remaining at end of fiscal year	946,092

The above excavation is exclusive of 319,275 yards of fill in harbor division of canal between the mouth and station 36, and 17,083 yards of fill in Old River between stations 221 and 234, no estimate being given the contractor for these. the first fill falling under a special agreement with the contractor (see Report Chief of Engineers, 1901, p. 2059), and the second being traceable to the discharge of material into Old River during December.

TABLE II.—*Monthly output and general conditions under which dredging was done.*

DREDGE No. 4.

Month.	Output.	Engine hours.	Average— Pipe line.	Average— Lift.	Ruling material.
1901.	*Cubic yds.*		*Feet.*	*Feet.*	
July					
August	73,238	440	1,324	15	Brown clay, sand, some loam.
September	186,688	498	1,156	9	Soft silt (in Barnett Lake).
October	122,031	537	890	18	Gray, blue, and brown clays.
November	105,068	535	1,042	21	Brown clay, some sand.
December	99,380	548	1,601	25	Gray and brown clays.
1902.					
January	112,551	517	1,520	24	Blue and brown clays.
February	90,000	521	2,146	19	Black clay, some sand.
March	116,044	596	1,283	17	Gray and brown clay, some sand.
April	158,852	531	1,001	5	Gray and brown clay (main cut); soft silt (harbor division).
May	186,504	539	1,052	5	Soft silt, some clay.
June	203,271	554	1,021	6	Soft silt, gray clay, and sand.
Totals and averages	1,453,627	5,816	1,276	15	

DREDGE No. 5.

Month.	Output.	Engine hours.	Average— Pipe line.	Average— Lift.	Ruling material.
1901.					
July	112,350	533	1,110	17	Gray, blue, and brown clays, some sand.
August	28,936	200	1,259	18	Gray and brown clays, some sand.
September	74,934	359	1,187	15	Yellow and brown clays and sand.
October	154,258	460	1,190	18	Soft silt (in Barnett Lake), black and blue clays.
November	80,921	544	1,845	22	Gray, brown, and blue clays.
December	82,119	521	1,287	25	Do.
1902.					
January	119,138	595	1,342	25	Do.
February	93,493	436	1,351	15	Blue clay and sand.
March	124,811	484	940	8	Gray and brown clay, some sand, silt.
April	126,284	558	713	5	Brown and black clay, some sand, silt.
May	116,345	570	907	14	Do.
June	140,214	558	1,044	14	Dark clay and sand.
Totals and averages	1,253,803	5,818	1,182	16	

TABLE II.—*Monthly output and general conditions under which dredging was done*—Continued.

CLAM-SHELL DREDGE CALIFORNIA.

Month.	Output.	Engine hours.	Haul.	Capacity of dipper.	Ruling material.
1901.	*Cu. yds.*		*Miles.*	*Cu. yds.*	
July	38,301	492	0.5	2¼	Quicksand, sand, some clay, loam.
August	41,215	518	.6	2¼	Sandy loam, some red clay.
September	34,495	416	1.5	2¼	Sandy silt, loam, some quicksand.
October	42,576	425	1.8	....	Silt, gray and brown clay, and sand.
November	7,470	88	1.6	[a] 2¼ [b] 7	Sandy loam and clay, some buckshot.
December	44,392	331	1.6	7 5¼	Do.
1902.					
January	47,896	517	1.2	5¼	Sand, gray clay, and silt.
February	29,858	387	1.1	5¼	Fine sand, gray clay, and silt.
March	42,384	505	1.4	5¼	Sand and stiff clay, some buckshot.
April	48,936	454	1	5¼	Sand, stiff clay, quicksand.
May	48,233	528	1.2	5¼	Quicksand, clay, and sand.
June	37,528	536	1.3	5¼ [c] 2¼	Quicksand, silt, and coarse sand.
Totals and averages	463,284	5,197	1.2		

[a] The 2¼-yard dipper was used November 1 to 4.
[b] The 7-yard dipper was used November 26 to December 18.
[c] The 2¼-yard dipper was used June 14 to 20.

This table is based on the daily estimates for the several dredges adjusted to agreement with the total excavation as measured in place.

Dredge No. 4 was laid up during the entire month of July and first five days of August for the installation of a new Climax boiler. Advantage was taken of the stop to place the machinery of the dredge in thorough repair, and the cabin also was rebuilt. The dredge was again laid up from January 3 to 8 for putting new liners in main pump, repairing friction clutches, etc. Dredge No. 5 was laid up from August 12 to September 6 for repairs to boiler, suction ladder, and machinery generally; from January 30 to February 3 repairing furnace walls, and from March 19 to 23 overhauling main pump, riveting ladder, and moving from Barnett Lake to harbor division of canal. The running record of these dredges is very satisfactory and shows careful and efficient handling as well as proper original design. During the month of March dredge No. 4 shows an average loss of only one hour and five minutes per working day, and the record of No. 5 for May is equally good. The clam shell was laid up from November 3 to 26 for alterations and general repairs. The main frictions were moved nearer the axis of hull, with a view to diminishing the velocity of swing in the upper boom. This dredge, which had been using a 2¼-yard dipper, resumed work with a 7-yard dipper, weighing 12 tons, and although the alterations in the machinery enabled the boom to be maneuvered with safety, the dipper was too heavy for the suspending tackle, and frequent breakages occurred here. A new dipper, 5¼ yards capacity, 9 long tons in weight, was received about the middle of December and was put into use on the 19th of that month. There was a gratifying decrease in breakages, but the hoisting tackle was plainly too weak for the dipper. Stronger gin sheaves were procured and larger hoisting cables put in, but there is still a heavy loss of time due to minor breakages in this part of the machine. The heaviest loss of time for this dredge was in waiting for scows. This loss was especially heavy during first half of the year, on account of an insufficient number of mud scows and an inefficient dredge tender. In January two mud scows belonging to the previous contractors for the canal and already in the Lake Centennial pool were purchased. Later the seagoing tug *Berenice*, of Mobile, Ala., was chartered to act as tender. This tug arrived at mouth of canal February 28, and was taken into the pool as soon as the river stage permitted passage over the spillway at West Pass. The new tender has kept the clam shell fairly supplied with scows, and during April, May, and June delays from this cause dropped to second place.

TABLE III.—*Classified statement of delays.*

Cause of delay.	Dredge—		
	No. 4.	No. 5.	Clam shell.
	Hours.	*Hours.*	*Hours.*
Repairs to main engine and boilers	90	72	64
Cleaning and repairing main pump	52	178	
Cleaning and repairing suction pipe and cutter	138	70	
Additions, repairs, etc., to pipe line	325	432	
Repairs to spuds and connections	6	84	127
Repairs to friction drums and other deck machinery	25	12	86
Moving dredge	81	60	44
Shifting swinging cables and repairs to same	44	74	
Waiting for, shifting, and repairing scows			728
Repairing dipper, hoisting cables, and gins			572
Meals			55
Sundays, holidays, and miscellaneous	1,302	1,326	1,317
Single stops not included in above:			
Installation of new boiler, rebuilding cabin, etc	881		
General overhauling of dredge		630	
Shifting position of main frictions			570
Total	2,944	2,942	3,563

DISPOSITION OF MATERIAL.

Material moved by the hydraulic dredges while working in the main cut has been applied to the construction of a training dike on south side of canal and a dam across the south branch of Barnett Lake, to make the dike continuous from Old River to Lake Centennial, or has been wasted back of the above dike and dam and in Old River. The dike had been built from a point 800 feet west of the main bank of Lake Centennial nearly to Barnett Lake during the previous fiscal year and a dike had been built in 1895-1897, under contracts Nos. 1 and 2, extending from the bank of Old River 2,400 feet toward Barnett Lake. The dike, as built hydraulically, has its crest at the average elevation of 89.6 feet, mean Gulf level, excepting the first 1,000 feet west of Barnett Lake, where the crest averages at 87.1 feet, and the Barnett Lake dam, standing at 82 feet. The crown of dike averages about 10 feet and the side slopes vary from 8:1 to 25:1, according to the material employed in construction. The average depth of fill is 7.7 feet for the dike and 9.3 feet for Barnett Lake dam. It was intended to build the dike to an elevation of 90 feet, mean Gulf level, it having been concluded from the experience of the previous fiscal year in building an impounding dike hydraulically that this was about all that could be attained by this method.

The stretch immediately west of Barnett Lake was left incomplete because the adjacent stretch of canal is in lake, the soft mud bottom of which is unfit for building, and suitable material had to be pumped back from the stretch between Barnett Lake and Old River, which resulted in a prohibitive length of pipe line before the proposed grade could be reached. Dredge No. 4 began discharging on the Barnett Lake dam August 17, pumping from the east of that lake, and running a low preliminary fill across the lake to stop back flow toward the north, where canal was to be excavated. The material discharged was a stiff clay, which settled badly into the mud bottom of lake, but did not spread to any considerable extent. Dredge No. 4 filled on the dam until September 8, by which time she had dug into the lake and reached a material that would not build. Dredge No. 5, advancing behind No. 4, filled on the dam from September 14 to 22, bringing the crest up to 80.1 feet, mean Gulf level, or 7.4 feet above the original bottom, this fill representing a total of 109,400 cubic yards pumped onto the dam. Work on the dam was resumed in February, dredge No. 5 discharging here from February 3 to March 8, on which date 119,500 additional cubic yards had been placed on the dam and its east approach and all material in canal available for this purpose had been exhausted.

From the experience gained in 1901 it was apparent that the dam could not be built to the grade originally proposed with the material within a reasonable distance, and on resumption of this work in 1902 a grade of 86 feet was decided on. A force of laborers, in charge of Junior Engineer L. L. Griffith, was placed on the dam to prevent excessive dissipation of the discharged material. Post and plank dikes were put in to train the flow along the line of proposed fill, these dikes being stepped in as the dump built up. It was found necessary to supplement the plank sheathing with brush in sandy material, and in some cases the best results were obtained with posts and brush alone. A much more rapid fill was obtained by these expedients, but the improvement was not such as to recommend the hydraulic dredge as a levee builder. The fill was carried across the lake practically to the 86-foot level, but serious settlement occurred in places, resulting in an average elevation of 83.5 feet for the dam proper when filling was discontinued. On June 20 the average elevation of the dam was 82 feet.

Material moved by the hydraulics while working in the harbor division has been wasted on the willow flat west of the canal and into the Mississippi River, or pumped into the Lake Centennial pool, where at a reasonable distance from canal, and deposited along the impounding dike.

Dredge No. 4, while working in Old River, discharged into that river between 700 and 800 feet to the west of the canal cut.

Material moved by the clam shell has been deposited on the Lake Centennial dam. A fill has been carried across the lake with crest at an average elevation of 53.5 feet, mean Gulf level, but rising at several points as high as 58 feet, the fill being concentrated at these points during the early part of year, to make a study of the slopes assumed by the deposited material. The height of fill varies from 2 to 34 feet, with an average value of 16 feet. The material was dumped in an average water depth of 26 (—) feet, this being taken as the difference between the average elevation of water surface in lake and the average elevation of the crest of fill, increased by half the average fill. The characteristic cross section at the high points of the dam has a crown of 30 feet, and side slopes of 7:1 for the first 10 feet below the crest and 20:1 thence to bottom of fill. This slope, concave upward, applies to sandy material built to within about 14 feet of water surface. For alluvial material the side slopes were generally convex upward when the fill reached any considerable height, and as a rule the slope did not steepen near the crest for any material until the dump came within about 20 feet of water surface.

The total amount of material deposited on the dam April 17, 1901, to June 30, 1902, is 537,348 cubic yards.

TABLE IV.—*Disposition of material, November 19, 1900, to June 30, 1902.*

Where disposed.	Used in construction.	Wasted.
	Cubic yds.	*Cubic yds.*
In Mississippi River		71,760
On impounding dike west of harbor canal	640,000	
Reenforcing this dike, pool side	97,650	
In flat west of harbor canal		1,007,489
In front of Steamboat Slough dike	1,375	
On dam at crevasse west of West Pass	28,600	
On Lake Centennial dam	537,348	
On "approach" to Lake Centennial dam	326,590	
Behind approach		89,330
On training dike, Lake Centennial to Barnett Lake	280,730	
Behind this dike		297,740
On Barnett Lake dam	228,902	
Behind this dam		148,417
Training dike, Barnett Lake to Old River	271,380	
Behind this dike		416,520
In Old River, at east bank, south of head of main cut		474,110
In Old River west of canal cut		124,537
Total	2,412,575	2,629,903

The fill of 319,275 cubic yards in harbor division between mouth of canal and station No. 36, and 17,083 cubic yards in Old River between stations Nos. 221 and 234, is included in the above.

The table is based on the daily estimates for the several dredges, adjusted to agreement with the total excavation as measured in place.

POOL MAINTENANCE.

During November and December a small levee was thrown up on the impounding dike west of the harbor canal, raising the crest of dike from a little less than 29 feet on the Kleinston gauge to about 32 feet. A spillway was put in the dike at the east side of Steamboat Slough, 122 feet long, with crest at 30 feet. The dike was raised with the view of impounding water in the lake to 29 feet after the succeeding high water, outflow at the West Pass and Jackson street spillways being controlled by flash boards.

At the time when the crevasse in the impounding dike at Steamboat Slough was closed, June 14, 1901, the water surface in the Lake Centennial pool stood at 27.9 feet on the Kleinston gauge (73.07 feet, mean Gulf level). On July 1 the pool had drained down to the crest of the West Pass spillway, and stood at 27.3 feet on the gauge. The pool then fluctuated between very narrow limits, but with a general downward tendency, until January 30, standing on that date at 25.1 feet. The lake then rose slowly until February 10, when a rise in the Mississippi overtopped the West Pass and Jackson street spillways and began to fill the pool. On the night of February 13-14 Steamboat Slough spillway was overtopped, and later there was an inflow across the neck between the dams at West Pass, through a breach in the impounding dike west of canal station No. 16, and over several low places in the Jackson street dike. At the time the inflow began the lake stood at 25.2 feet, about 2 feet below the river. The spillway area was inadequate, and the river gained on the lake until the 12th, when the fall into the pool was 3.7 feet. After the 12th the lake gained on the river and the two were at the same elevation on the 16th. For about twenty-four hours there was inflow at Jackson street and outflow at West Pass, after which time the rapid decline in the river caused the lake to discharge at all points of communication. After the impounding dikes came above water the outflow was checked by building a levee around the Jackson street spillway and by placing flash boards and sacks of earth on the West Pass spillway. The pool declined rapidly until February 20, then slowly, standing at 28.7 feet March 11.

Considerable damage was done to the West Pass and Jackson street spillways during the period of inflow, the heavy overfall scouring holes on the lake side of the spillways and undermining the sheet piling under the adjacent ends of the aprons. Part of the apron at Jackson street was carried away, and the inner apron at West Pass was undermined and dropped below its normal position. The scour at the spillways was checked by sacks of earth held in place by rows of closely driven piling and serious consequences were prevented. Further damage was done at the West Pass spillway while the lake was draining, the outer apron being undermined and heavy scour resulting on the outer slope of the dam beyond the end of apron. The river slope was protected by rows of piling with sacks of earth between, the sacks stepping down in elevation from end of apron to toe of slope.

The main rise of 1901-1902 began March 3, and on the 13th water began to flow into the pool, which filled without serious damage to spillways or impounding dikes, and reached the level of the river March 16. The river reached a maximum of 41.22 feet April 18, then declined slowly. The lake emptied at West Pass and the adjacent neck of ground without doing material damage, and the impounding dikes came out safely May 3.

The West Pass and Steamboat Slough spillways were left in such bad condition by the first rise that it was thought best to remove them and restore the original cross section of the dikes in which they were placed. This was done in May and June, on force account, by the Government, the contractors having signified their intention of making only such repairs as would insure the pool until the next high water. It is intended later to provide a spillway of large capacity, and so located—as at Jackson street dike—that a breach, if it occurred, would not endanger the success of the canal by affording an alternative outlet to the Mississippi River.

During May and June the lake level has stood at about 29 feet on the gauge, fluctuating above and below that elevation by small amounts.

A report on changes in the harbor division of canal has been submitted.

A map showing route of canal from the Mississippi River to Old River, location of impounding dikes, etc., is published in the Report of the Chief of Engineers for 1901, page 2066; and a map showing the Yazoo, Old, and Mississippi rivers in the vicinity of Vicksburg, Miss., and the center line of proposed canal is published in the Report of the Chief of Engineers for 1894, page 1494.

Very respectfully, your obedient servant,

T. C. THOMAS,
Assistant Engineer.

Capt. CHAS. L. POTTER,
Corps of Engineers.

V 8.

IMPROVEMENT OF YAZOO RIVER, MISSISSIPPI.

Work for the improvement of navigation of this river was continued during the period of low water by the U. S. snag boat *Columbia*, a light wooden boat which has been used since the powerful iron and steel snag boat *John R. Meigs* was destroyed in 1898. (See Report of the Chief of Engineers, 1898, p. 2009.)

From July 18 to August 13, 1901, the *Columbia* worked upstream from the mouth to the head of the river. During this period the stages were very low and effective work was performed for the removal of obstructions in the channel. August 13 to 31 the snag boat was transferred to Tallahatchie River, but returned to the Yazoo September 1 and continued operations until December 21, when they were suspended by high water. The work was carried on under the local supervision of James H. Britton, master of the *Columbia*, except during the period of his absence on Red River July 18 to October 4, when T. G. Ledbetter was the master in temporary charge.

The following is a summary of the work performed by the *Columbia* in Yazoo River during the year, viz:

Snags pulled	834
Stumps pulled, cut, and destroyed	520
Shore snags cut	3,676
Logs removed from channel	109
Side jams removed	21
Leaning trees felled	2,137
Leaning trees topped	116
Trees girdled	5,290
Logs cut up along banks	15
Square yards of willows and brush cut	6,950

Wreck removed, viz—sunken coal barge at Templeton Landing.

The river and harbor act approved June 13, 1902, consolidated the work of improving Yazoo River and its tributaries by the following item of appropriation:

Improving Yazoo River and its tributaries, the Tallahatchie and Big Sunflower rivers, Mississippi: Continuing improvement and for maintenance, $55,000, of which amount a sum not exceeding $4,000 shall be used for the removal of obstructions at the lower end of Tchula Lake, and the unexpended balance of $2,036.14 for construction of pumping dredge boat, and of $5,000 for removing the bar at Yazoo City, is hereby transferred to the fund for the general improvement of the river.

The following allotments of the appropriation of $55,000 have been approved:

For continuing improvement of Yazoo River	$21,000
For removal of obstructions at lower end of Tchula Lake	4,000
For completing improvement of Tallahatchie River	10,000
For completing improvement of Big Sunflower River	20,000
Total	55,000

Preparations are in progress for repairs of plant, etc., and work for the general improvement of Yazoo River and for the removal of obstructions at the lower end of Tchula Lake will be commenced as soon as practicable. Operations for the removal of snags, wrecks, sunken logs, leaning timber, tree slides, etc., obstructing the navigation of Yazoo River, will extend from the mouth to the head of that stream, and will be repeated from time to time, when the stages are favorable, until the funds for the purpose are exhausted.

Reference is invited to the estimate heretofore made for a new steel-hull snag boat to replace the *John R. Meigs*, destroyed September 3, 1898. The snag boat *Columbia* is a small wooden-hull boat, which has been transferred from the improvement of Ouachita and Black rivers for temporary use in Yazoo River and tributaries. The life of a wooden boat in this district is short, and there is need for a more powerful boat in this system of rivers, so constructed as to last for a period of fifteen or twenty years.

Money statement.

July 1, 1901, balance unexpended	$17,255.40
Allotment from amount appropriated by river and harbor act approved June 13, 1902, including work at lower end of Tchula Lake	25,000.00
	42,255.40
June 30, 1902, amount expended during fiscal year	8,241.02
July 1, 1902, balance unexpended	34,014.38
July 1, 1902, outstanding liabilities	15.40
July 1, 1902, balance available	33,998.98
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:	
For new steel snag boat	60,000.00
For maintenance of improvement	([a])
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

The appropriations for improving Yazoo River, Mississippi, have been as follows:

By act of—	
March 3, 1873	$40,000
March 3, 1875	12,000
August 14, 1876	15,000
June 18, 1878	25,000
March 3, 1879	15,000
June 14, 1880	12,000
March 3, 1881	6,000
August 2, 1882	8,000
July 5, 1884	10,000
August 5, 1886	15,000
August 11, 1888	$32,000
September 19, 1890	25,000
July 13, 1892	20,000
August 18, 1894	20,000
June 3, 1896	20,000
March 3, 1899	20,000
June 13, 1902 (allotment)	21,000
Total	316,000

No work has been done in Tchula Lake since 1895. The appropriations for its improvement have been as follows:

By act of—	
March 3, 1881	$3,000
August 2, 1882	2,500
July 5, 1884	1,500
August 5, 1886	2,000
August 11, 1888	3,000
September 19, 1890	3,000
July 13, 1892	$3,000
August 17, 1894	3,000
June 13, 1902 (allotment)	4,000
Total	25,000

COMMERCIAL STATISTICS.

Yazoo River was navigable from mouth to head the entire fiscal year, but the larger steamboats had difficulty in crossing the bar at the entrance from Mississippi River during the month of October, 1901.

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[a] Biennial appropriation should be $30,000.

List of steamboats engaged in navigation of Yazoo River during the fiscal year ending June 30, 1902.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
						Light.	Loaded.			
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*			
Rees Pritchard	Stern-wheel.	196	150.3	31	3.3	1.5	4	Vicksburg and Greenwood.	36	750
								Yazoo City and Big Sunflower River.	20	250
Hallette	do	196	161	30.5	4.5	1.8	5	Vicksburg and Greenwood.	15	500
								Vicksburg and Tallahatchie River.	5	51
City of Greenwood.	do	97	130	28	3.5	2	4.5	Vicksburg and Greenwood.	13	......
Wichita	do	98	136	28	3	1.3	2.5	Vicksburg and Big Sunflower River.	30	450
Edna[a]	do	50	75	18	3	2	3	do	2	......
City of Knoxville	do	147	130	18	3	1.5	3	Yazoo City and Big Sunflower River.	129	1,200
								Vicksburg and Yazoo River.	15	200
Elk[a]	do	100	153	22	4	2.5	4	Vicksburg and Greenwood.	20	400
								Yazoo City and Big Sunflower River.	50	250
Emma Francis[a]	do	48	60	14	2	1.8	3	Greenwood and Belzona.	57	......
Harry Higbee[b]	do	93	113.6	22.2	3.7	2.3	3.5	New Orleans and Yazoo River.	1	......
Choctaw[a]	do	223	127	24	4	1.7	4	Greenwood and Tallahatchie River.	156	1,560
Ruth[b]	do	60	97.2	18	3.7	1.5	2	Vicksburg and Yazoo River.	5	......
Alda[a]	do	73	121	21.2	4	2	4	do	10	150
								Yazoo City and Big Sunflower River.	129	1,800
Maggie[a]	do	50	85	19	3.5	2	3.5	do	125	500
Joe Seay[a]	Tug	27	75	16	6.5	7	8	Vicksburg and Yazoo City and points below.	8	......
May[a]	Gasoline.	......	......	......	......	......	......	Vicksburg and Big Sunflower River.	2	......
Amy[a]	do	......	......	......	......	......	......	do	1	......

[a] With barges. [b] Towboats.

The steamers *Rees Pritchard* and *City of Knoxville* sunk in Yazoo River in November, 1901, but were raised subsequently.

Summary of commerce reported.

Articles.	1901-2.
	Tons.
Cotton	11,563
Cotton seed	25,438
Hides and skins	11
Live stock	2,454
Lumber	10,430
Staves	29,032
Provisions	10,400
Grain	9,800
Saw logs	16,100
Miscellaneous	17,620
Coal	1,800
Total freights for Yazoo proper	134,648
Total freights from tributaries	132,609
Total freight Yazoo and tributaries	267,257
Estimated value	$9,198,000

Receipts and shipments of bales of cotton at Greenwood and Yazoo City, Miss., 1901–2.

Routes.	Receipts.	Shipments.
GREENWOOD.		
Southern Rwy	15,579	25,443
Illinois Central R. R	19,001	27,965
River	11,197	
Wagon	11,464	
Total	57,241	53,408
YAZOO CITY.		
Illinois Central R. R	(a)	(a)
River	(b)	(a)
Wagon	(a)	(a)
Total		

[a] Not received.

The receipts of cotton at Yazoo City during the fiscal year 1900–1901 were reported to have been 42,005 bales, and 64,199 bales during the fiscal year 1901–2. The details of receipts and shipments were not furnished.

[For railroads see report for 1901.]

V 9.

IMPROVEMENT OF TALLAHATCHIE RIVER, MISSISSIPPI.

The U. S. snag boat *Columbia*, T. G. Ledbetter, master, was employed in this stream from August 13 to 31, 1901, during which period operations were carried from the mouth upstream to Sharkey Landing and the following obstructions to navigation destroyed, viz:

Snags pulled	118
Stumps pulled, cut, and destroyed	52
Shore snags cut	1,344
Logs removed from channel	48
Side jams removed	3
Leaning trees felled	502
Leaning trees topped	2,979
Square yards of willows and brush cut	250

With the allotment from the appropriation for "Improving Yazoo River and its tributaries," contained in the river and harbor act of June 13, 1902, work will be resumed as soon as the plant at Vicksburg can be repaired and put in commission. Operations for the removal of snags, sunken logs, leaning timber, etc., to give ease and safety to navigation, will extend over the river from its mouth to the mouth of Coldwater River.

Money statement.

July 1, 1901, balance unexpended	$1,030.67
Allotment from amount appropriated by river and harbor act approved June 13, 1902, for improving Yazoo River and its tributaries	10,000.00
	11,030.67
June 30, 1902, amount expended during fiscal year	1,030.67
July 1, 1902, balance unexpended	10.000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	(a)

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[a] Biennial appropriation should be $5,000.

The following appropriations have been made:

By act of—	
March 3, 1879	$6,000
June 14, 1880	9,000
March 3, 1881	3,000
August 2, 1882	3,000
July 5, 1884	3,000
August 5, 1886	3,500
August 11, 1888	5,000

By act of—	
September 19, 1890	$5,000
July 13, 1892	5,000
August 18, 1894	4,000
June 3, 1896	4,000
March 3, 1899	5,000
June 13, 1902 (allotment)	10,000
Total	65,500

The river and harbor acts of 1880, 1881, and 1882 required the expenditure of $10,000 above the mouth of Coldwater River to Batesville, a part of the river not included in the original or present project and for which no further appropriation seems to be needed.

COMMERCIAL STATISTICS.

Tallahatchie River was navigable to Sharkey Landing the entire fiscal year, and to Coldwater River at high stages.

List of stern-wheel steamboats engaged in navigation during the year.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
					Light.	Loaded.			
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*			
Choctaw[a]	223	127	24	4	1.5	3.5	Greenwood and Shady Grove	156	1,560
Hallette	196	161	30.5	4.5	1.1	5	Vicksburg and Philipp	5	51

[a] With barges.

Summary of commerce reported.

Articles.	1901-1902.
	Tons.
Cotton	3,600
Cotton seed	9,840
Hides and skins	1
Live stock	1,500
Lumber	2,500
Staves	750
Provisions	6,000
Grain	4,000
Saw logs	30,000
Miscellaneous	4,000
Total	62,191
Estimated value	$2,630,000

[For railroads see report for 1901.]

V 10.

IMPROVEMENT OF BIG SUNFLOWER RIVER, MISSISSIPPI.

No work was performed for the improvement of this stream during the fiscal year ending June 30, 1902. The expenditures made during the year were for the care of plant laid up at Vicksburg, Miss.

With the allotment from the appropriation for "Improving Yazoo River and its tributaries" contained in the river and harbor act of June 13, 1902, work will be resumed as soon as the plant can be repaired and put in commission. Operations for the removal of snags, stumps, tree slides, sunken logs, leaning timber, etc., obstructing navigation, and for repairing and building inexpensive dams of piles, logs, and brush, to scour a depth of about 40 inches on the bars, will extend from the mouth upstream as far as the interests navigation require. When the project for improvement was entered upon, in 1879, Big Sunflower River was filled by every high stage of the Mississippi, affording navigation at such times to Clarksdale, but now that the Mississippi front has been closed by levees the stream is dependent upon its natural drainage with backwater at flood stages in the lower part from the Yazoo. As boats can not ascend to Clarksdale, it does not appear desirable to carry work that far upstream unless it is found advisable to remove sources of drift.

Money statement.

July 1, 1901, balance unexpended	$293.50
Allotment from amount appropriated by river and harbor act approved June 13, 1902, for improving Yazoo River and its tributaries	20,000.00
	20,293.50
June 30, 1902, amount expended during fiscal year	293.50
July 1, 1902, balance unexpended	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	(a)
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

The appropriations have been as follows:

By act of—		By act of—	
March 3, 1879	$20,000	July 13, 1892	$5,000
June 14, 1880	8,000	August 18, 1894	5,000
March 3, 1881	4,000	June 3, 1896	5,000
August 2, 1882	5,000	March 3, 1899	5,000
July 5, 1884	5,000	June 13, 1902 (allotment)	20,000
August 5, 1886	5,000		
August 11, 1888	5,000	Total	97,000
September 19, 1890	5,000		

COMMERCIAL STATISTICS.

Big Sunflower River was reported to have been navigable for small steamboats for about ten months of the fiscal year, or with exception of the months of September and October.

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[a] Biennial appropriation should be $6,000.

List of stern-wheel steamboats engaged in navigation during the year.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
					Light.	Loaded.			
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*			
ichita	98	136	28	3	1.3	3	Vicksburg and Woodburn Vicksburg and Osceola	24 6	450
City of Knoxville	147	130	18	3	1.5	3	Yazoo City and Campbellsville.	129	1,200
Rees Pritchard	196	150.3	31	3.3	1.5	4	do	20	250
Maggie[a]	50	85	19	3.5	2	3.5	do	125	500
Alda[a]	73	121	21.2	4	2.5	4	do	129	1,800
Elk[a]	100	153	22	4	2.5	4	do	50	250
Edna[a]	50	75	18	3	2	3	Vicksburg and Woodburn	2	
Ruth[b]	60	97.2	18	3.7	1.5	2	Vicksburg and Big Sunflower River.	3	
May (gasoline)[a]							do	2	
Amy (gasoline)[a]							do	1	

[a] With barges.

[b] Towboat.

Summary of commerce reported.

Articles.	1901-2.
	Tons.
Cotton	4,365
Cotton seed	15,605
Hides	8
Live stock	374
Saw logs	13,066
Lumber	5,124
Staves	8,705
Miscellaneous	4,960
Total down freight	52,207
Return freight	18,211
Total	70,418
Estimated value	$1,734,000

V 11.

FINAL REPORT ON SURVEY OF OUACHITA AND BLACK RIVERS, ARKANSAS AND LOUISIANA.

[Printed in House Doc. No. 448, Fifty-seventh Congress, first session.]

Office of the Chief of Engineers,
United States Army,
Washington, March 6, 1902.

Sir: The river and harbor act of August 18, 1894, in the item making appropriation for improving Ouachita and Black rivers, Arkansas and Louisiana, directed the Secretary of War to submit plans and estimates for the improvement of said Ouachita River by locks and dams to give slack-water navigation as far above its mouth as in his judgment is practicable.

A preliminary report, dated February 7, 1900, by Maj. Thomas L. Casey, Corps of Engineers, was transmitted to Congress and printed in House Doc. No. 480, Fifty-sixth Congress, first session, and in the Annual Report of the Chief of Engineers for 1900, page 2544.

I have the honor now to submit herewith a copy of final report, dated February 22, 1902, with map[a] by Capt. Chas. L. Potter, Corps of Engineers, on survey of Ouachita and Black rivers (one stream, called Ouachita above the town of Trinity, La., and Black below that place) and tributaries with plan and estimate for improvement, as required by the terms of the act above mentioned.

The plan presented in this report provides for a navigable depth of 6½ feet from the mouth of the river up to a point above the town of Camden, Ark., 360 miles, by a system of nine locks and movable dams, at an estimated cost of $1,998,576.

The following tributaries were included in the survey: Tensas River and Bayou Maçon, Louisiana; Bœuf River, Louisiana and Arkansas; Saline River, Arkansas; Bayou Bartholomew, Louisiana and Arkansas; Bayou D'Arbonne, Louisiana.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. ELIHU ROOT,
Secretary of War.

REPORT OF CAPT. CHARLES L. POTTER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., February 22, 1902.

GENERAL: I have the honor to make final report of the survey of the Ouachita and Black rivers, provided for by act of Congress of August 18, 1894.

This survey has gone on continuously since that time, and has been very complete in every detail of any importance. (For description of the methods used and details of the work see Annual Reports of the Chief of Engineers for 1900, pp. 2504 and 2544, and for 1901, p. 2035.)

The system as now proposed consists of nine locks and dams, varying in lift from 5.6 to 11.1 feet, and giving a navigable depth of 6.5 feet from the junction with the Red River to Camden, Ark., a distance of 350 miles; in fact, about 10 miles above Camden, or a total distance of 360 miles. Each dam consists of a navigable pass 130 feet long, with a needle dam—needles 15 feet long; a drift pass 40 feet wide, with Chittenden drum, and a weir with a needle dam, the needles being 9 feet long.

In order to locate the locks and dams at points where suitable foundations could be had, it was necessary to make the lift in some of the locks greater than was originally intended, and in order to keep the length of the needles at 15 feet (the greatest length that it is believed can be readily handled), it became necessary in some instances to raise the fixed dam in the navigable pass above low water. A computation of the fall through this pass at the lowest stage at which it will be used shows a fall of only 4 inches.

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[a] Not reprinted; printed in House Doc. No. 448, Fifty-seventh Congress, first session.

The locks, as designed, are 49 feet wide and 394 feet long, intended to take in a towboat with two barges tandem. It is thought, however, that a shortening of the lock, with a corresponding width to allow a towboat to take two barges abreast, would be more advantageous to navigation, and the cost would certainly not be increased by the change.

With a view to extending the present navigation to a point farther up river, it is recommended that Locks Nos. 4 and 6 be built first, and on account of the fact that each structure must be built in halves, allowing the river to pass through the other half, it is recommended that funds be made available for two locks and dams at a time, allowing the construction of two locks in two low-water seasons—one-half of both to be built each season.

By following the construction of Nos. 4 and 6 by the construction of Nos. 2, 3, and 8 the navigation would be improved so as to give between 3 and 4 feet all the way up to Camden, and the ultimate depth of 6½ feet could then be secured by building Nos. 1, 5, 7, and 9.

The total cost of the improvement for a depth of 6½ feet (all nine locks) is estimated at $1,998,576.

The cost of the improvement for a depth of 3 to 4 feet (Nos. 2, 3, 4, 6, and 8) is estimated at $1,149,287.

The cost of materially assisting the present navigation of the stream (Nos. 4 and 6) is estimated at $433,262.

For detailed statements, with tables, maps,[a] and plans, see report of Mr. H. M. Marshall, assistant engineer, in charge of the survey.

Very respectfully, your obedient servant,

Chas. L. Potter,
Captain, Corps of Engineers

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

REPORT OF MR. M. H. MARSHALL, ASSISTANT ENGINEER.

United States Engineer Office,
Vicksburg, Miss., February 17, 1902.

Captain: I have the honor to make final report on survey of Ouachita and Black rivers, Louisiana and Arkansas, with a view to their permanent improvement by locks and dams.

The survey was ordered by act of Congress August 18, 1894, and work began in September following. Details of methods and results accomplished to February, 1900, are set out in a special report contained in the Annual Report of the Chief of Engineers, United States Army, for 1900, at page 2544 et seq. Later reports will be found for the same year at page 2504, and in Annual Report of 1901, at page 2035.

The survey has developed very thoroughly all that was contemplated in the beginning, except the outline of overflow above Monroe. This has not been attempted for several reasons, principally because the overflow will not be affected in any way by the lock and dam system proposed. The cost of the survey was estimated at $150,000, and the expenditures to January 31, 1902, were $131,346.71. Considerable work yet remains to put the notes in shape for final record and to finish titles, etc., on the maps. The original project did not provide for printing the maps, but if that should be done it would prove a very important item in the results, and in view of the allotment being in arrears of the estimate by $14,000, I recommend that they be printed.

The general plan for the system of locks herein estimated is the same as set out in the preliminary report, and the cost is very much reduced. The lessened cost was foreshadowed. The number of locks has been reduced to nine, though the length of needles has been maintained at 15 feet. This has necessitated raising the fixed part of the dams somewhat above low water, but there is no probability and scarcely a possibility of injury from this source. The swell head when the lock wall goes under water will be only 4 inches. The decrease in number of locks was forced by the inability to find suitable foundations in the vicinity of the other proposed lock sites. The decrease in number, however, is in the direction of economy, as it increases the height of the lift. The raise in the fixed part of the dam has been somewhat compensated by lowering the miter sills in the locks. This makes the draft unequal through the different locks, but 6½ feet is the least provided for, and, of course, as far as navigation is concerned, the excess in some does no harm.

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[a] Maps not printed; profile sheet printed in House Doc. No. 448, Fifty-seventh Congress, first session.

Having to locate the dams according to the available foundations, forces inequality of lifts varying from 5½ to 11¼ feet. Fortunately, the system could be adjusted so that the smaller lifts occur at the poorer foundations.

The following table gives details of pool lengths, lifts, etc.:

Lock and dam.		Distance above mouth.	Length of pool above dam.	Elevation of miter sill.	Draft.	Elevation of lower pool.	Lift.	Elevation of upper pool.	Elevation of top of lock and dam.	Height of lock wall.
No.	Site.									
		Miles.	*Miles.*	*Meters C. D.*	*Meters.*	*Meters C. D.*	*Meters.*	*Meters C. D.*	*Meters C. D.*	*Meters.*
1	New Hope	37.8	37.8	5.5	2.9	8.4	1.7	10.1	10.8	5.3
2	Catahoula Shoals	75.6	58.0	8.0	2.1	10.1	3.4	13.5	14.2	6.2
3	Calls Landing	133.6	49.5	10.5	3.0	13.5	3.2	16.7	17.4	6.9
4	Monroe	183.1	17.0	14.7	2.0	16.7	3.0	19.7	20.4	5.7
5	Rock Row Shoals	200.1	38.4	17.2	2.5	19.7	2.3	22.0	22.7	5.5
6	Roland Raft	238.5	30.0	19.5	2.5	22.0	1.7	23.7	24.4	4.9
7	Perigeethe Shoals	268.5	28.7	21.0	2.7	23.7	1.7	25.4	26.1	5.1
8	Franklin Shoals	297.2	30.0	23.1	2.3	25.4	2.6	28.0	28.7	5.6
9	Newport Landing	327.2	32.8	25.5	2.5	28.0	2.5	30.5	31.2	5.7

The estimates are for lock chambers 49 feet and 394 feet, width and length, respectively, closed by metal gates.

I have not felt at liberty to vary from these dimensions, though an increase in width and decrease in length possibly would be more suitable to the traffic. Any change in that way would not materially alter the cost.

The dam is estimated to consist of a navigable pass, 130 feet opening; a weir with 140 feet opening, having the fixed substructure 6 feet higher than the substructure of the pass; a drift pass with 40 feet opening, having the fixed substructure on the level of that of the weir. The superstructure of the pass and weir consists of metal A frames which can be raised to support the wooden needles which compose the face of the dam, or lowered flat on top of the substructure when the dam is not in use. The upper part of the drift pass to be controlled by a Chittenden drum.

The completed system of nine locks, giving 6½ feet least draft, is estimated to cost $1,998,576.

Locks 1, 5, 7, and 9 could be omitted, and the system would afford light-draft navigation, say, between 3 and 4 feet, at a cost for the remaining locks of $1,149,287.

If the traffic should prove to be not fully accommodated by the light draft afforded, the omitted locks could be put in at the original estimate.

If only one lock should be put under construction at a time, then Lock No. 4, just below Monroe, would be most advisable to begin with, for it would by itself be more useful in connecting an almost inaccessible country with Monroe, a large distributing point, and it would prolong the period of navigation in the upper river.

The next in order of construction should be No. 6, near Roland Raft.

Inasmuch as only the lock and part of the dam can be put under construction during one low-water period, to avoid interfering with navigation and the flow of the river, and the remaining part of the dam must be built at the next low-water period, it will be economy of time at no increase of available funds to authorize the construction of two locks and dams simultaneously, part to be paid out of future appropriations.

The estimated value of commerce reported on Ouachita and Black rivers for the fiscal year ending June 30, 1901, was $8,642,000. Statistics from records and officials of the 21 counties and parishes tributary to the river show as follows, to wit:

Total assessed valuation	$36,427,617
Annual volume of trade	22,124,505
Annual freight bills	1,713,316
Number of bales of cotton raised	384,771

Estimates of cost of locks and dams in detail, with summary and tables of data, are appended to this report.

The following maps and profiles also accompany the report, viz: One map of Ouachita River and tributaries, showing location of locks, scale 1:400,000; 1 blue-print title sheet Ouachita and Black rivers; 2 blue-print index sheets Ouachita and Black rivers, scale 1:200,000; 1 blue-print profile sheet Ouachita and Black rivers, scale 1:500,000; 8 blue-print profile sheets Ouachita and Black rivers, scale 1:10,000; 58 blue-print map sheets Ouachita and Black rivers, scale 1:10,000; 22 blue-print map sheets Tensas River, scale 1:10,000; 3 blue-print profile sheets Tensas River, scale 1:10,000; 1 blue-print title sheet Tensas River and Bayou Maçon; 13 blue-print map sheets Bayou Maçon, scale 1:10,000; 3 blue-print profile sheets Bayou Maçon, scale, 1:10,000; 1 blue-print title sheet Bœuf River; 18 blue-print map sheets Bœuf River, scale 1:10,000; 3 blue-print profile sheets Bœuf River, scale 1:10,000; 1 blue-print map sheet Saline River, scale 1:10,000.

The maps and profiles of Bayou Bartholomew are not completed. Neither are those of Bayou D'Arbonne. Of the former there will be 20 map sheets and 4 profile; of the latter, 4 map sheets and 2 profile.

Very respectfully, your obedient servant,

H. M. Marshall,
Assistant Engineer.

Capt. Chas. L. Potter,
Corps of Engineers, U. S. A.

Estimate of cost of Lock and Dam No. 1, at New Hope Landing, Louisiana.

LOCK.		
Concrete, 6,573 cubic meters	$52,584	
Grillage, 123,000 feet B. M	3,690	
Piles, 1,159 piles	11,590	
Sheet piles	3,750	
Excavation, 11,000 cubic meters	2,750	
Gates	13,470	
Valves	5,000	
Emergency dam	13,590	
		$106,424
DAM.		
Fixed ironwork	7,880	
Trestles	4,093	
Needles	1,380	
Sills	178	
Iron, pumps, etc	3,242	
Concrete, 3,831 cubic meters	30,648	
Cribs, timber, 96,000 feet B. M	2,880	
Cribs, riprap, 1,033 cubic meters	1,550	
Piles, 976 piles	9,760	
Timber, 194,700 feet B. M	5,841	
Sheet piles	4,966	
Excavation	2,115	
		74,533
MISCELLANEOUS.		
Cofferdam	10,000	
Lock houses	5,000	
Needle boat	1,500	
Crabs	500	
Land	1,000	
Back fill	405	
Paving	1,012	
		19,417
		200,374
Contingencies and engineering, 10 per cent		20,037
Total		220,411

Estimate of cost of Lock and Dam No. 2, at Catahoula Shoals, Louisiana.

LOCK.		
Concrete, 8,141 cubic meters	$65,128	
Grillage, 123,000 feet B. M	3,690	
Piles, 1,369 piles	13,690	
Sheet piles	3,750	
Excavation	2,750	
Gates	13,470	
Valves	5,000	
Emergency dam	13,590	
		$121,068
DAM.		
Fixed ironwork	11,062	
Trestles	5,248	
Needles	1,873	
Sills	178	
Iron, pumps, etc	3,242	
Concrete, 5,040 cubic meters	40,320	
Cribs, timber, 126,600 feet B. M	3,798	
Cribs, riprap, 1,412 cubic meters	2,118	
Piles, 1,256 piles	12,560	
Timber, 209,683 feet B. M	6,290	
Sheet piles	6,636	
Excavation	2,440	
		95,765
MISCELLANEOUS.		
Cofferdam	10,000	
Lock houses	5,000	
Needle boat	1,500	
Crabs	500	
Land	1,000	
Back fill	226	
Paving	562	
		18,788
		235,621
Contingencies and engineering, 10 per cent		23,562
Total		259,183

Estimate of cost of Lock and Dam No. 3, at Calls Landing, Louisiana.

LOCK.		
Concrete, 10,283 cubic meters	$82,264	
Grillage, 123,000 feet B. M	3,690	
Piles, 1,655 piles	16,550	
Sheet piles	3,750	
Excavation	2,750	
Gates	13,470	
Valves	5,000	
Emergency dam	13,590	
		$141,064
DAM.		
Fixed ironwork	6,962	
Trestles	3,781	
Needles	1,247	
Sills	178	
Iron, pumps, etc	3,242	
Concrete, 4,420 cubic meters	35,360	
Cribs, timber, 120,132 feet B. M	3,604	
Cribs, riprap, 1,431 cubic meters	2,147	
Piles, 941 piles	9,410	
Timber, 192,854 feet B. M	5,786	
Sheet piles	4,666	
Excavation	2,420	
		78,803

MISCELLANEOUS.

Cofferdam	$10,000	
Lock houses	5,000	
Needle boat	1,500	
Crabs	500	
Land	1,000	
Back fill	1,080	
Paving	1,800	
		$20,880
		240,747
Contingencies and engineering, 10 per cent		24,075
Total		264,822

Estimate of cost of Lock and Dam No. 4, at Monroe, La.

LOCK.

Concrete, 6,780 cubic meters	$54,240	
Grillage, 123,000 feet B. M	3,690	
Piles, 1,188 piles	11,880	
Sheet piles	3,750	
Excavation	2,750	
Gates	13,470	
Valves	5,000	
Emergency dam	13,590	
		$108,370

DAM.

Fixed ironwork	11,149	
Trestles	5,279	
Needles	1,887	
Sills	178	
Iron, pumps, etc	3,242	
Concrete, 5,314 cubic meters	42,512	
Piles, 1,242 piles	12,420	
Timber, 208,697 feet B. M	6,261	
Sheet piles	6,550	
Excavation	1,988	
		91,466

MISCELLANEOUS.

Cofferdam	10,000	
Lock houses	5,000	
Needle boat	1,500	
Crabs	500	
Land	1,000	
Back fill	191	
Paving	675	
		18,866
		218,702
Contingencies and engineering, 10 per cent		21,870
Total		240,572

Estimate of cost of Lock and Dam No. 5 at Rock Row Shoals, Louisiana.

LOCK.

Concrete, 7,173 cubic meters	$57,384	
Grillage, 123,000 feet B. M	3,690	
Piles, 1,239 piles	12,390	
Sheet piles	3,750	
Excavation	2,750	
Gates	13,470	
Valves	5,000	
Emergency dam	13,590	
		$112,024

DAM.

Fixed ironwork	$9,143	
Trestles	4,561	
Needles	1,580	
Sills	178	
Iron, pumps, etc	3,242	
Concrete, 4,549 cubic meters	36,392	
Piles, 1,088 piles	10,880	
Cribs, timber, 127,708 feet B. M	3,831	
Cribs, riprap, 1,396 cubic meters	2,094	
Timber, 204,737 feet B. M	6,022	
Sheet piles	5,565	
Excavation	2,000	
		$85,488

MISCELLANEOUS.

Cofferdam	10,000	
Lock houses	5,000	
Needle boat	1,500	
Crabs	500	
Land	1,000	
Back fill	731	
Paving	1,462	
		20,193
		217,705
Contingencies and engineering, 10 per cent		21,771
Total		239,476

Estimate of cost of Lock and Dam No. 6, at Roland Raft, Arkansas.

LOCK.

Concrete, 5,681 cubic meters	$45,448	
Grillage, 123,000 feet B. M	3,690	
Piles, 1,040	10,400	
Sheet piles	3,750	
Excavation	2,750	
Gates	13,470	
Valves	5,000	
Emergency dam	13,590	
		$98,098

DAM.

Fixed ironwork	5,568	
Trestles	3,282	
Needles	1,033	
Sills	178	
Iron, pumps, etc	3,242	
Concrete, 3,252 cubic meters	26,016	
Piles, 794 piles	7,940	
Timber, 184,983 feet B. M	5,549	
Sheet piles	3,767	
Excavation	2,000	
		58,575

MISCELLANEOUS.

Cofferdam	10,000	
Lock houses	5,000	
Needle boat	1,500	
Crabs	500	
Land	1,000	
Paving	500	
		18,500
		175,173
Contingencies and engineering, 10 per cent		17,517
Total		192,690

Estimate of cost of Lock and Dam No. 7, at Perigeethe Shoals, Arkansas.

LOCK.		
Concrete, 6,202 cubic meters	$49,616	
Grillage, 123,000 feet B. M	3,690	
Piles, 1,096 piles	10,960	
Sheet piles	3,750	
Excavation	2,750	
Gates	13,470	
Valves	5,000	
Emergency dam	13,590	
		$102,826
DAM.		
Fixed ironwork	4,042	
Trestles	2,736	
Needles	800	
Sills	178	
Iron, pumps, etc	3,242	
Concrete, 2,019 cubic meters	16,152	
Cribs, timber, 53,076 feet B. M	1,592	
Cribs, riprap, 553 cubic meters	830	
Piles, 639 piles	6,390	
Timber, 176,758 feet B. M	5,303	
Sheet piles	3,041	
Excavation	2,000	
		46,306
MISCELLANEOUS.		
Cofferdam	10,000	
Lock houses	5,000	
Needle boat	1,500	
Crabs	500	
Land	1,000	
Paving	500	
		18,500
		167,632
Contingencies and engineering, 10 per cent		16,763
Total		184,395

Estimate of cost of Lock and Dam No. 8, at Franklin Shoals, Arkansas.

LOCK.		
Concrete, 7,210 cubic meters	$57,680	
Grillage, 123,000 feet B. M	3,690	
Piles, 1,244 piles	9,952	
Sheet piles	3,750	
Excavation	2,750	
Gates	13,470	
Valves	5,000	
Emergency dam	13,590	
		$109,882
DAM.		
Fixed ironwork	4,042	
Trestles	2,736	
Needles	800	
Sills	178	
Iron, pumps, etc	3,242	
Concrete, 2,194 cubic meters	17,552	
Cribs, timber, 62,384 feet B. M	1,872	
Cribs, riprap, 644 cubic meters	966	
Piles, 597 piles	4,776	
Timber, 174,492 feet B. M	5,235	
Sheet piles	2,783	
Excavation	2,000	
		46,182

MISCELLANEOUS.		
Cofferdam	$10,000	
Lock houses	5,000	
Needle boat	1,500	
Crabs	500	
Land	1,000	
Paving	500	
		$18,500
		174,564
Contingencies and engineering, 10 per cent		17,456
Total		192,020

Estimate of cost of Lock and Dam No. 9, at Newport Landing, Arkansas.

LOCK.		
Concrete, 7,750 cubic meters	$62,000	
Grillage, 123,000 feet B. M	3,690	
Piles, 1,316 piles	13,160	
Sheet piles	3,750	
Excavation	2,750	
Gates	13,470	
Valves	5,000	
Emergency dam	13,590	
		$117,410
DAM.		
Fixed ironwork	4,042	
Trestles	2,736	
Needles	800	
Sills	178	
Iron, pumps, etc	3,242	
Concrete, 2,494 cubic meters	19,952	
Cribs, timber, 74,464 feet B. M	2,234	
Cribs, riprap, 814 cubic meters	1,221	
Piles, 625 piles	6,250	
Timber, 175,983 feet B. M	5,279	
Sheet piles	2,526	
Excavation	2,000	
		50,460
MISCELLANEOUS.		
Cofferdam	10,000	
Lock houses	5,000	
Needle boat	1,500	
Crabs	500	
Land	1,000	
Paving	500	
		18,500
		186,370
Contingencies and engineering, 10 per cent		18,637
Total		205,007

Summary of cost of locks and dams in Ouachita and Black rivers, Arkansas and Louisiana.

For navigable depth not less than 6.5 feet:	
Lock and Dam—	
No. 1, at New Hope Landing, Louisiana	$220,411
No. 2, at Catahoula Shoals, Louisiana	259,183
No. 3, at Calls Landing, Louisiana	264,822
No. 4, at Monroe, Louisiana	240,572
No. 5, at Rock Row Shoals, Louisiana	239,476
No. 6, at Roland Raft, Arkansas	192,690
No. 7, at Perigeethe Shoals, Arkansas	184,395
No. 8, at Franklin Shoals, Arkansas	192,020
No. 9, at Newport Landing, Arkansas	205,007
Total	1,998,576

For navigable depth of not less than 3 feet:

Lock and Dam—	
No. 2, at Catahoula Shoals, Louisiana	$259,183
No. 3, at Calls Landing, Louisiana	264,822
No. 4, at Monroe, Louisana	240,572
No. 6, at Roland Raft, Arkansas	192,690
No. 8, at Franklin Shoals, Arkansas	192,020
Total	1,149,287

For two most important:

Lock and Dam—	
No. 4, at Monroe, Louisiana	$240,572
No. 6, at Roland Raft, Arkansas	192,690
Total	433,262

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TABLE No. 1.—*Precise levels.—Instrumental constants.*

TABLE A.

Bubble tube.	Value one division for a distance of 1 meter.	Date of determination.	Stretch to which constant is applied.
	Millimeters.		
L. S. No. 4	0.016	Feb. 16, 1889	Delta to Grand Bend, La.
Do	.016	June 4, 1889	Do.
Do	.022	Oct. 18, 1889	Do.
Do	.017	Oct. 8, 1891	Grand Bend to Smithland, La.
Do	.018	Jan. 20, 1892	Do.
Do	.017	Jan. 21, 1892	Do.
Do	.016	do	Do.
Do	.015	Sept. 24, 1894	Little Rock to Frenchport, Ark.
Do	.016	Jan. 18, 1895	Do.
L. S. No. VIII	.015	Sept. 9, 1899	Archibald to Three Rivers, La.
Do	.015	Dec. 18, 1899	Do.
Do	.017	Feb. 24, 1900	Delta, La., to Greenville, Miss.
M. R. C. No. 1	.013	Feb. 16, 1889	Delta to Grand Bend, La.
Do	.008	July 5, 1889	Do.
Do	.014	Oct. 18, 1889	Do.
M. R. C. No. 2	.015	June 4, 1889	Do.
Do	.021	Dec. 28, 1889	Do.
Do	.015	Oct. $\left\{\begin{matrix}22\\23\end{matrix}\right\}$1890	Delta, La., to Greenville, Miss.
R. R. S. No. 1	.017	Sept. 19, 1892	Do.
Do	.019	June 6, 1893	Do.
Do	.020	Oct. 25, 1893	Jonesville, La., to Natchez, Miss.
Do	.020	Jan. 15, 1894	Do.
Do	.019	Apr. 17, 1894	Do.
Do	.019	Sept. 24, 1894	Jonesville to mouth of Black River, La.
Do	.019	Nov. 13, 1894	Do.
Do	.019	Sept. 12, 1895	Champagnolle, Ark., to Monroe, La.
Do	.019	Nov. 26, 1895	Do.
Do	.019	Dec. 11, 1897	Rayville to Concordia, La.
Do	.019	Feb. 3, 1898	Do.
Do	.020	May 15, 1899	Delta, La., to Greenville, Miss.
R. R. S. No. 2	.016	Sept. 13, 1892	Do.
Do	.017	Oct. 26, 1893	Monroe to Jonesville, La.
Do	[*].012	May 12, 1897	Frenchport to Champagnolle, Ark.
Do	.014	May 28, 1897	Do.
Do	.014	May 29, 1897	Do.
Do	.014	June 10, 1897	Parkeville, La., to Greenville, Miss.
Do	.014	Sept. 17, 1897	Do.
Do	.013	Dec. 8, 1897	Glendora to Farmerville, La.
Do	.014	Jan. 6, 1898	Do.
Do	.013	May 7, 1900	Camden, Ark., to Shreveport, La.
Do	.013	July 11, 1900	Do.

[*] Old bubble tube broken; new one in use after May 22, 1896.

TABLE B.

Kern level.	Pivot correction for a distance of 1 meter.	Date of determination.	Stretch to which constant is applied.
	Millimeters.		
L. S. No. 1	+0.010	Feb. 16, 1889	Delta to Coushatta, La.
Do	+ .018	June 4, 1889	Do.
Do	+ .021	Oct. 17, 1889	Coushatta to Grand Bend, La.
Do	+ .005	Oct. 6, 1891	Grand Bend to Smithland, La.
Do	− .001	Oct. 8, 1891	Do.
Do	+ .002	Jan. 20, 1892	Do.
Do	− .005	Sept. 25, 1894	Little Rock to Frenchport, Ark
Do	+ .003	Jan. 18, 1895	Do.
Do	− .006	Jan. 9, 1897	Delta, La., to Greenville, Miss.
Do	− .009	Sept. 17, 1899	Archibald to Three Rivers, La.
Do	− .003	Dec. 18, 1899	Do.
Do	− .007	Feb. 28, 1900	Delta, La., to Greenville, Miss.
Do	− .013	Mar. 21, 1900	Do.

TABLE No. 1.—*Precise levels.—Instrumental constants*—Continued.

TABLE B—Continued.

Kern level.	Pivot correction for a distance of 1 meter.	Date of determination.	Stretch to which constant is applied.
	Millimeters.		
M. R. C. No. 1	− .016	Feb. 16, 1889	Delta to Coushatta, La.
Do	− .006	Oct. 17, 1889	Coushatta to Grand Bend, La.
M. R. C. No. 2	+ .014	May 29, 1889	Delta to Coushatta, La.
Do	+ .002	Dec. 28, 1889	Coushatta to Grand Bend, La.
Do	− .001	Oct. $\left\{\begin{matrix}22\\23\end{matrix}\right\}$ 1890	Delta, La., to Greenville, Miss.
R. R. S. No. 1	+ .007	Sept. $\left\{\begin{matrix}19\\20\end{matrix}\right\}$ 1892	Do.
Do	+ .007	June 6, 1893	Do.
Do	− .010	Oct. $\left\{\begin{matrix}25\\27\end{matrix}\right\}$ 1893	Jonesville, La., to Natchez, Miss.
Do	− .000	Jan. 15, 1894	Do.
Do	+ .002	Apr. 17, 1894	Monroe to Jonesville, La.
Do	+ .013	Sept. 24, 1894	Jonesville to mouth of Black River, La.
Do	− .013	Nov. 13, 1894	Do.
Do	+ .013	Sept. 12, 1895	Champagnolle, Ark., to Monroe, La.
Do	+ .021	Nov. 26, 1895	Do.
Do	− .006	Jan. 9, 1897	Delta, La., to Greenville, Miss.
Do	+ .029	Oct. 25, 1897	Parkeville, La., to Greenville, Miss.
Do	+ .008	Dec. 11, 1897	Rayville to Concordia, La.
Do	− .008	Feb. 3, 1898	Do.
Do	− .000	May 15, 1899	Delta, La., to Greenville, Miss.
R. R. S. No. 2	− .008	Sept. 13, 1892	Do.
Do	− .020	Nov. 18, 1893	Jonesville, La., to Natchez, Miss.
Do	− .009	Feb. 25, 1897	Delta, La., to Greenville, Miss.
Do	+ .006	May 12, 1897	Frenchport to Champagnolle, Ark.
Do	+ .008	May 28, 1897	Do.
Do	+ .007	May 29, 1897	Do.
Do	+ .011	June 10, 1897	Parkeville, La., to Greenville, Miss.
Do	− .000	Sept. 17, 1897	Do.
Do	+ .002	Dec. 8, 1897	Glendora to Farmerville, La.
Do	+ .001	Jan. 15, 1898	Do.
Do	+ .008	May 7, 1900	Camden, Ark., to Shreveport, La.
Do	+ .008	July 11, 1900	Do.

TABLE C.

Rod.	Length of 1 meter on rod.	Correction for spur.
	Millimeters.	*Millimeters.*
II	[a] 999.866	+47.5
IV	[b] 999.928	+48.2
XII	[c] 999.973	−50.1
XV	[e] 1,000.053	−55.5
XVI	[c] 1,000.011	−55.9
R. R. S. No. 3	[d] 999.744	[e] −51.5
R. R. S. No. 4	[f] 999.856	[e] −51.5
R. R. S. No. 5	[f] [g] 999.808	[e] −51.5
R. R. S. No. 6	[f] [g] 999.877	[e] −51.3

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[a] Mean of Lake Survey and Mississippi River Commission determinations. (See Mississippi River Commission Report, 1881, p. 51.)

[b] By comparison with Rod II, Feb. 16, 1889. Erroneous value (999.890) published in Chief of Engineers' Report, 1893, p. 1945.

[c] As determined by the Mississippi River Commission. (See Chief of Engineers' Report, 1884, p. 2464.)

[d] As determined by the United States Coast and Geodetic Survey in June, 1894. (See Chief of Engineers' Report, 1894, p. 1496.)

[e] As determined Sept. 21, 1892.

[f] As determined by comparison with R. R. S. rod No. 3.

[g] Erroneous value, which was published in Chief of Engineers' Report, 1894, p. 1495, was derived from erroneous value of Rod II. (See Chief of Engineers' Report, 1893, p. 1945.)

TABLE 1 D.—*Precise levels, etc.—Tabulated results.*

[The asterisk following "elevation above Gulf level" in last column of this table, refers to the following:

P. B. M. XLV, Smithland, La., elevation 14.8234 meters above mean Gulf level at Biloxi, Miss. (See Report of Chief of Engineers for 1900, p. 4721.)

P. B. M. XLV, Smithland, La., elevation 21.0048 meters above Cairo datum. (See Report of Chief of Engineers for 1893, footnote, p. 1956.)]

MONROE, LA., TO LITTLE ROCK, ARK.

Bench.	Distance— Between benches.	Distance— From Monroe.	Difference of elevation. Forward.	Difference of elevation. Back.	Difference of elevation. Mean.	Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
P. B. M. 27							29.9638	78.025
P. B. M. 25	0.44	0.44	+0.8304	+0.8297	+0.8300	−0.2	30.7936	80.748
P. B. M. 24	0.61	1.05	−2.8140	−2.8082	−2.8111	+0.4	27.9831	71.527
T. B. M. 96	0.71	1.76	+0.7968	+0.7961	+0.7965	+0.3	28.7795	74.140
T. B. M. 95	1.86	3.62	+0.0663	+0.0649	+0.0656	+0.3	28.8451	74.356
P. R. P. Pargoud	2.74	6.36	+8.8224	+8.8349	+8.8287	−1.7	37.6718	103.314
T. B. M. 94a	0.00	6.36	+0.5574	+0.5582	+0.5578	−1.9	38.2294	105.143
T. B. M. 93	0.00	6.36	−7.1573	−7.1626	−7.1600	−0.2	31.0711	81.658
P. R. P. Zeph	8.71	15.07	−0.8233	−0.8170	−0.8201	−0.1	30.2511	78.968
T. B. M. 87	0.00	15.07	−1.6297	−1.6297	−1.6297	+0.3	28.6218	73.622
T. B. M. 86	1.32	16.39	−0.5339	−0.5348	−0.5343	+0.4	28.0876	71.870
P. R. P. Rock Row	4.59	20.98	+1.4285	+1.4411	+1.4348	+0.1	29.5221	76.576
T. B. M. 83	0.00	20.98	+1.2845	+1.2838	+1.2841	−0.2	30.8059	80.788
T. B. M. 81	1.91	22.89	−0.5429	−0.5443	−0.5436	−0.1	30.2624	79.005
P. R. P. Glendora	3.53	26.42	+0.6353	+0.6381	+0.6367	−0.2	30.8990	81.093
T. B. M. 79	0.00	26.42	+1.3215	+1.3195	+1.3205	−0.5	32.2192	85.425
T. B. M. 77	3.61	30.03	−0.5829	−0.5803	−0.5816	−0.4	31 6377	83.516
T. B. M. 75	3.56	33.59	+1.5483	+1.5417	+1.5466	−0.7	33.1840	88.590
P. R. P. Parkeville	1.68	35.27	−3.4526	−3.4565	−3.4546	+0.1	29.7302	77.259
T. B. M. 74	0.00	35.27	+1.2218	+1.2217	+1.2218	−0.2	30.9517	81.265
P. R. P. Cashill	5.37	40.64	−3.0131	−3.0085	−3.0108	+0.5	27.9416	71.391
T. B. M. 70	0.00	40.64	+0.0415	+0.0415	+0.0415	+0.4	27.9830	71.527
P. R. P. Fishtrap	8.11	48.75	−0.6181	−0.6113	−0.6147	+0.6	27.3685	69.511
P. R. P. Alabama	4.23	52.98	−0.0096	−0.0106	−0.0101	+0.6	27.3584	69.477
T. B. M. 63	0.00	52.98	+1.0992	+1.0998	+1.0995	+0.3	28.4576	73.084
T. B. M. 62	0.60	53.58	−0.3625	−0.3628	0.3626	+0.4	28.0951	71.894
P. R. P. Frank Pierre	3.75	57.33	−4.8955	−4.9020	−4.8988	+1.5	23.1974	55.826
T. B. M. 59	0.00	57.33	+0.4303	+0.4292	+0.4298	+1.4	23.6271	57.236
P. R. P. Shiloh	6.09	63.42	−0.1846	−0.1760	−0.1803	+1.5	23.4469	56.644
T. B. M. 55	0.00	63.42	+1.3090	+1.3088	+1.3089	+1.2	24.7555	60.938
T. B. M. 53	2.80	66.22	−0.6261	−0.6205	−0.6233	+1.3	24.1323	58.893
P. R. P. Lake	6.52	72.74	+0.0253	+0.0342	+0.0297	+1.3	24.1620	58.991
T. B. M. 49	0.00	72.74	+1.4442	+1.4425	+1.4434	+1.0	25.6051	63.725
T. B. M. 48	0.61	73.35	−1.6486	−1.6485	−1.6485	+1.3	23.9569	58.318
T. B. M. 46	2.84	76.19	+2.2778	+2.2785	+2.2781	+0.8	26.2345	65.790
P. R. P. Lapile	3.12	79.31	−1.3532	−1.3495	−1.3514	+1.1	24.8834	61.358
T. B. M. 44	0.00	79.31	+1.1914	+1.1905	+1.1910	+0.9	26.0742	65.264
P. R. P. Belle Point	8.02	87.33	−0.3135	0.3072	−0.3104	+0.9	25.7638	64.246
T. B. M. 39	0.00	87.33	+1.0958	+1.0961	+1.0960	+0.7	26.8596	67.841
P. R. P. Eutaw	7.94	95.27	+1.3594	+1.3760	+1.3727	+0.4	28.2320	72.344
T. B. M. 32a	0.00	95.27	+0.8938	+0.8945	+0.8941	+0.2	29.1259	75.276
P. R. P. Jacks Island	8.00	103.27	+0.8012	+0.8157	+0.8085	0.0	29.4342	77.928
T. B. M. 25a	0.00	103.27	+1.0612	+1.0588	+1.0600	−0.2	30.9940	81.405
P. R. P. Careyville	2.18	105.45	+0.1742	+0.1793	+0.1768	−0.3	31.1707	81.985
T. B. M. 23	0.00	105.45	+1.1124	+1.1118	+1.1121	−0.5	32.2826	85.633
P. R. P. Pigeon Hill	5.86	111.31	+1.6886	+1 6868	+1.6877	−1.0	33.9698	81.168
T. B. M. 18	0.00	111.31	−2.6533	−2.6540	−2.6536	−0.3	31.3169	82.465
P. R. P. Fletcher	3.78	115.09	+0.5565	+0.5577	+0.5571	−0.4	31.8739	84.299
T. B. M. 15	0.00	115.09	+0.4388	+0.4392	+0.4390	−0.5	32.3128	85.732
T. B. M. 14	0.90	115.99	−1.0890	−1.0917	−1.0903	−0.3	31.2227	82.156
P. R. P. Franklin	6.88	122.87	−2.4203	−2.4247	2.4225	+0.3	28.8008	74.209
T. B. M. 8	0.00	122.87	+0.3645	+0.3648	+0.3647	+0.2	29.1654	75.406
T. B. M. 7	0.53	123.40	+1.5243	+1.5217	+1.5230	−0.2	30.6880	80.402
P. R. P. Bell field	4.46	127.86	+0.1372	+0.1303	+0.1337	−0.2	30.8217	80.838
T. B. M. 1	2.02	129.88	+8.5201	+8.5143	+8.5172	−2.1	39.3370	108.777
P. R. P. Champagnolle	0.41	130.29	−3.4701	−3.4716	−3.4709	−1.3	35.8669	97.389
P. R. P. Eldorado	2.70	133.00	−2.8873	−2.8877	−2.8875	−0.9	32.9798	87.918
P. R. P. Smackover	6.50	139.5	−0.4373	−0.4427	−0.4400	−0.8	32.5399	86.477
P. R. P. Leppard	6.50	146.0	+1.1957	+1.2054	+1.2005	1.0	33.7402	90.415
T. B. M. 18a	0.00	146.0	−1.0396	−1.0373	−1.0384	−0.9	32.7019	87.008
P. R. P. Little Bay	2.50	148.5	+1.0373	+1.0415	+1.0394	−1.0	33.7412	90.418
T. B. M. 13	0.30	148.8	+1.4799	+1.4843	+1.4821	−1.2	35.2231	95.280
T. B. M. H	1.40	150.2	+1.2449	+1.2582	+1.2516	−1.4	36.4745	99.386
P. R. P. Beech Hill	5.10	155.3	−1.9613	1.9619	−1.9616	−1.1	34.5132	92.951
P. R. P. Walnut Hill	3.50	158.8	−0.8213	−0.8131	−0.8172	−0.9	33.6962	90.271
T. B. M. 5	0.00	158.8	+4.1169	+4.1174	+4.1172	−1.6	37.8127	103.776
P. R. P. Frenchport II	5.40	164.2	+5.8551	+5.8595	+5.8573	−2.4	43.6692	122.990
P. R. P. Frenchport I	0.10	164.3	−2.7402	−2.7415	−2.7409	−2.0	40.9287	113.999

TABLE 1 D.—*Precise levels, etc.—Tabulated results*—Continued.

MONROE, LA., TO LITTLE ROCK, ARK.—Continued.

Bench.	Distance— Between benches.	Distance— From Monroe.	Difference of elevation. Forward.	Difference of elevation. Back.	Difference of elevation. Mean.	Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
P. B. M. Elliott	8.40	172.7	+42.6887	+42.6933	+42.6910	− 8.6	83.6131	254.036
Gauge B. M. A	14.70	187.4	−36.7443	−36.7466	−36.7454	− 2.9	46.8734	133.503
P. B. M. Camden IV	0.00	187.4	− 5.6270	− 5.6270	− 5.6270	− 2.0	41.2473	115.044
P. R. P. Camden III	0.00	187.4	− 2.2520	− 2.2500	− 2.2510	− 1.7	38.9966	107.660
P. B. M. Camden II	0.60	188.0	+27.9454	+27.9360	+27.9407	− 6.1	66.9329	199.313
P. R. P. Camden I	−0.60	187.4	−18.5367	−18.5333	−18.5350	− 3.2	48.4008	138.514
P. B. M. Lester	11.80	199.2	− 7.5460	− 7.5448	− 7.5454	− 2.0	40.8566	113.762
P. B. M. Chidester	12.50	211.7	+35.5404	+35.5501	+35.5453	− 7.6	76.3963	230.362
P. B. M. Little Missouri	13.00	224.7	−19.6933	−19.6763	−19.6848	− 4.5	56.7146	165.790
P. B. M. Wheelen	6.40	231.1	+26.3896	+26.3912	+26.3904	− 8.6	83.1009	252.357
P. B. M. Gurdon II	10.40	241.5	−13.4298	−13.4066	−13.4182	− 6.5	69.6848	208.342
P. B. M. Gurdon I	0.00	241.5	+ 0.1517	+ 0.1513	+ 0.1515	− 6.6	69.8362	208.838
P. B. M. Smithton	4.30	245.8	− 0.7913	− 0.7923	− 0.7918	− 6.4	69.0446	206.242
P. B. M. Curtis	5.40	251.2	− 6.4400	− 6.4436	− 6.4418	− 5.4	62.6038	185.111
P. B. M. Gum Springs	7.90	259.1	+ 8.7897	+ 8.7697	+ 8.7797	− 6.8	71.3821	213.902
R. R. B. M. 7587	5.20	264.3	−10.3102	−10.3118	−10.3110	− 5.2	61.0727	180.087
P. B. M. Arkadelphia II	1.70	266.0	+11.0127	+11.0085	+11.0105	− 6.9	72.0815	216.206
P. B. M. Arkadelphia I	0.00	266.0	− 8.4957	− 8.4933	− 8.4945	− 5.6	63.5883	188.340
Gauge B. M. B	0.90	266.9	− 0.6542	− 0.6528	− 0.6535	− 5.5	62.9349	186.197
P. B. M. Ouachita R	0.00	266.9	+ 2.6558	+ 2.6558	+ 2.6558	− 5.9	65.5903	194.909
P. B. M. Daleville	0.60	267.5	− 2.4053	− 2.4027	− 2.4040	− 5.5	63.1867	187.023
P. B. M. Donaldson	16.90	284.4	+12.6271	+12.6270	+12.6271	− 7.5	75.8118	228.444
P. B. M. Malvern	15.70	300.1	+12.8806	+12.9068	+12.8937	− 9.5	88.7035	270.739
P. B. M. Traskwood	19.90	320.0	+ 6.4567	+ 6.4770	+ 6.4669	−10.6	95.1693	291.952
P. B. M. Saline River	11.10	331.1	− 2.9236	− 2.9163	− 2.9200	−10.1	92.2498	282.373
P. B. M. Benton	2.40	333.5	+ 4.8857	+ 4.8927	+ 4.8892	−10.9	97.1382	298.411
P. B. M. Alexander	16.40	349.9	+ 8.4836	+ 8.5142	+ 8.4989	−12.0	105.6360	326.291
P. B. M. Mablevale	6.00	355.9	− 4.9407	− 4.9350	− 4.9378	−11.4	100.6988	310.092
P. B. M. Ensign	4.70	360.6	− 5.1123	− 5.1044	− 5.1084	−10.6	95.5912	293.336
T. B. M. 11	0.00	360.6	− 0.3210	− 0.3220	− 0.3215	−10.6	95.2697	292.281
R. R. B. M. 14930	6.90	367.5	+ 0.9944	+ 0.9977	+ 0.9960	−10.7	96.2656	295.548
T. B. M. 4	1.50	369.0	+ 3.8836	+ 3.8842	+ 3.8839	−11.5	100.0487	307.961
T. B. M. 2	2.00	371.0	−13.8394	−13.8346	−13.8370	− 9.2	86.3140	262.901
P. B. M. I (or 3)	2.0	373.0	+ 0.2223	+ 0.2252	+ 0.2237	− 9.2	86.5377	263.633
P. B. M. O	0.0	373.0	+ 7.4473	+ 7.4437	+ 7.4455	−10.4	93.9820	288.056
P. B. M. A	0.0	373.0	+ 3.2907	+ 3.2903	+ 3.2905	−10.9	97.2720	298.850
P. B. M. B	0.0	373.0	− 0.4024	− 0.4023	− 0.4023	−10.8	96.8698	297.530
P. B. M. I (or 3)	(a)	....	....	....	....	− 9.2	86.5377	263.633
B. M. Whittemore	(a)	....	− 0.0120	....	− 0.0120	− 9.2	86.5257	263.594
P. B. M. I (or 3)	(a)	....	....	....	....	− 9.2	86.5377	263.633
B. M. Abert	(a)	....	− 5.1150	....	− 5.1150	− 8.5	81.3234	246.526
P. B. M. I (or 3)	(a)	....	....	....	....	− 9.2	86.5377	263.633
B. M. Merrill	(a)	....	− 2.3783	....	− 2.3783	− 8.8	84.1598	255.832
P. B. M. I (or 3)	(a)	....	....	....	....	− 9.2	86.5377	263.633
S. S. Gauge B. M	(a)	....	− 4.5155	....	− 4.5155	− 8.5	82.0229	248.821
P. B. M. O	(a)	....	....	....	....	−10.4	93.9820	288.056
B. M. Statehouse steps	(a)	....	− 0.0177	....	− 0.0177	−10.4	93.9643	287.999
B. M. cor. Main and Markham streets	(a)	....	− 0.7105	....	− 0.7105	−10.2	93.2540	285.668
T. B. M. 2	(a)	....	....	....	....	− 9.2	86.3140	262.901
Gauge B. M. A	(a)	....	− 6.3813	....	− 6.3813	− 8.2	79.9337	241.967
B. M. 1 (Ewens, 1887)	(a)	....	− 1.7660	....	− 1.7660	− 7.9	78.1680	236.174
No. 6 (Gauge B. M.)	(a)	....	+ 8.1951	....	+ 8.1951	− 9.2	86.2618	262.728

[a] At Little Rock, Ark.

P. B. M. 27 is used as initial bench.

From P. B. M. 27 to P. R. P. Champagnolle was run along dirt road and chain-line cut by Walter H. Polk September 12 to November 26, 1895.

From P. R. P. Champagnolle to P. R. P. Frenchport was run along chain-line cut by William R. Neely May 12 to 29, 1897.

From P. R. P. Frenchport to P. B. M. I (or 3) was run along dirt road and the St. Louis, Iron Mountain and Southern Railway track by T. C. Thomas October 18 to December 31, 1894.

Elevation of P. B. M. I (or 3), by United States Coast and Geodetic Survey, 263.591 feet, Gulf level. See their report for 1898–99, Appendix 8, page 483.

TABLE 1 D.—*Precise levels, etc.—Tabulated results*—Continued.

MONROE TO MOUTH OF BLACK RIVER, LOUISIANA.

Bench.	Distance. Between benches.	Distance. From Monroe.	Difference of elevation. Forward.	Difference of elevation. Back.	Difference of elevation. Mean.	Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
P. B. M. 27	(a)	....	....	....	....	....	29.9638	78.025
P. B. M. 28	(a)	....	−0.7480	−0.7504	−0.7492	+0.1	29.2147	75.568
P. B. M. 26	(a)	....	+1.6224	+1.6243	+1.6234	−0.2	30.8378	80.893
P. B. M. 25	(a)	....	−0.0451	−0.0473	−0.0462	−0.2	30.7916	80.741
P. B. M. 24	(a)	....	−2.8137	−2.8048	−2.8093	+0.4	27.9829	71.526
B. M. C. (Burrowes, 1883)	(a)	....	+2.8565	+2.8498	+2.8532	−0.2	30.8355	80.886
B. M. D. (Burrowes, 1883)	(a)	....	−0.1524	−0.1546	−0.1535	−0.1	30.6821	80.382
T. B. M. 102	[a] 3.59	3.59	−0.9942	−0.9817	−0.9880	0.0	29.6942	77.141
T. B. M. 103	2.13	5.72	+0.8374	+0.8430	+0.8402	−0.1	30.5343	79.897
T. B. M. 105	4.81	10.53	−2.5396	−2.5279	−2.5337	+0.3	28.0010	71.586
T. B. M. 110	8.81	19.34	+0.4095	+0.4151	+0.4123	+0.3	28.4133	72.938
P. B. M. 9, P. R. P. Logtown	0.00	19.34	−0.5676	−0.5673	−0.5674	+0.4	27.8460	71.077
T. B. M. 111	1.89	21.23	+0.5900	+0.5854	+0.5887	+0.3	28.4346	72.008
T. B. M. 113	3.12	24.35	+0.3041	+0.3127	+0.3084	+0.2	28.7429	74.020
T. B. M. 114	1.84	26.19	−0.1160	−0.1124	−0.1142	+0.3	28.6288	73.645
T. B. M. 119	9.24	35.43	−1.4773	−1.4718	−1.4745	+0.6	27.1546	68.809
P. B. M. 10, P. R. P. Blankston	0.00	35.43	−1.3893	−1.3886	−1.3890	+0.8	25.7658	64.252
T. B. M. 121	3.12	38.55	+2.3831	+2.3836	+2.3834	+0.4	28.1488	72.071
B. M. 30 B. (1873)	0.00	38.55	+0.3210	+0.3216	+0.3213	+0.3	28.4700	73.124
P. B. M. 125	6.06	44.61	−0.6852	−0.6767	−0.6810	+0.4	27.7891	70.891
T. B. M. 127	3.50	48.11	−1.0931	−1.0895	−1.0912	+0.7	26.6982	67.312
T. B. M. 128	1.73	49.84	−0.0186	−0.0153	−0.0170	+0.7	26.6812	67.255
P. B. M. 11	(b)	49.84	−1.2540	−1.2546	−1.2543	+0.9	25.4271	63.141
Railway B. M	(b)	49.84	+1.0913	+1.0922	+1.0917	+0.7	26.5186	66.722
Gauge B. M. B	(b)	49.84	+3.0717	+3.0746	+3.0732	+0.1	29.5912	76.803
T. B. M. 128A	(b)	49.84	−4.4810	−4.4872	−4.4841	+1.0	25.1080	62.094
Gauge B. M. A	(b)	49.84	−1.7770	−1.7797	−1.7784	+1.3	23.3299	56.261
T. B. M. 131	4.14	53.98	+3.1908	+3.2021	+3.1965	+0.7	26.5258	66.746
T. B. M. 133	2.84	56.82	−0.3369	−0.3303	−0.3336	+0.8	26.1923	65.652
T. B. M. 133a	0.00	56.82	−0.5023	−0.5027	−0.5025	+0.9	25.6899	64.003
P. B. M. 12	0.00	56.82	−0.8071	−0.8161	−0.8116	+1.0	24.8784	61.341
T. B. M. 134	0.83	57.65	+1.6972	+1.7017	+1.6995	+0.7	26.5776	66.916
T. B. M. 135	1.84	59.49	−0.5018	−0.5030	−0.5024	+0.8	26.0753	65.268
T. B. M. 137	1.40	60.89	−1.7108	−1.7125	−1.7116	+1.1	24.3640	59.653
T. B. M. 138	1.27	62.16	+0.8672	+0.8648	+0.8660	+0.9	25.2298	62.494
T. B. M. 140	3.66	65.82	−0.0960	−0.0914	−0.0937	+0.9	25.1361	62.187
T. B. M. 141	1.97	67.79	−0.0873	−0.0850	−0.0862	+0.9	25.0499	61.904
T. B. M. 142	1.91	69.70	+0.4771	+0.4716	+0.4744	+0.9	25.5243	63.460
P. R. P. Gibson	0.00	69.70	−0.6726	−0.6737	−0.6731	+1.1	24.8514	61.253
T. B. M. 143	1.32	71.02	+0.0252	+0.0261	+0.0256	+1.0	24.8769	61.336
P. B. M. 13, P. R. P. King	5.16	76.18	−0.2352	−0.2338	−0.2345	+1.1	24.6425	60.567
T. B. M. 149	4.94	81.12	−0.1476	−0.1409	−0.1442	+1.1	24.4983	60.094
T. B. M. 151	3.00	84.12	+0.4025	+0.4066	+0.4045	+1.0	24.9027	61.421
P. B. M. 14, P. R. P. Cottingham	0.00	84.12	−1.0852	−1.0858	−1.0855	+1.2	23.8174	57.860
T. B. M. 62	2.71	86.83	−0.2543	−0.2354	−0.2449	+1.3	23.5726	57.057
B. M. B	0.32	87.15	+0.9644	+0.9634	+0.9639	+1.1	24.5363	60.219
T. B. M. 61	0.00	87.15	−0.5640	−0.5644	−0.5642	+1.2	23.9722	58.368
T. B. M. 58	4.77	91.92	−0.5691	−0.5639	−0.5665	+1.3	23.4058	56.510
B. M. A	1.68	93.60	+1.0421	+1.0415	+1.0418	+1.1	24.4474	59.927
T. B. M. 54	4.84	98.44	+0.7038	+0.7143	+0.7090	+1.0	25.1568	62.253
P. B. M. 8, P. R. P. Stafford	8.69	107.13	−1.7979	−1.7909	−1.7944	+1.3	23.3622	56.367
T. B. M. 49	0.00	107.13	+0.5890	+0.5879	+0.5884	+1.2	23.9505	58.297
T. B. M. 49	....	107.13	....	....	....	+1.2	23.9505	58.297
B. M. 39 B (1873)	0.01	107.14	−0.1780	....	−0.1780	+1.2	23.7725	57.713
T. B. M. 49	....	107.13	....	....	....	+1.2	23.9505	58.297
P. B. M. 7, P. R. P., Catahoula	5.95	113.08	−0.3441	−0.3288	−0.3364	+1.3	23.6142	57.194
T. B. M. H	7.34	120.42	+0.9412	+0.9532	+0.9472	+1.1	24.5612	60.300
B. M. V (1858)	....	120.42	+2.1579	+2.1577	+2.1578	+0.6	26.7185	67.378
P. B. M. 6	....	120.42	+3.5665	+3.5666	+3.5665	−0.1	30.2843	79.077
T. B. M. 40	0.00	120.42	−1.6537	−1.6533	−1.6535	+0.3	28.6312	73.653
T. B. M. 38	3.29	123.71	−4.2231	−4.2237	−4.2234	+1.1	24.4086	59.800
T. B. M. 34	4.58	128.29	+0.2842	+0.2801	+0.2821	+1.1	24.6907	60.725
T. B. M. 29	8.69	136.98	−0.8348	−0.8241	−0.8294	+1.2	23.8614	58.004
P. B. M. 5	1.51	138.49	−1.3344	−1.3367	−1.3356	+1.5	22.5261	53.624
T. B. M. 28	0.00	138.49	+0.0886	+0.0886	+0.0886	+1.5	22.6147	53.914
P. B. M. 4	0.21	138.70	+0.0296	+0.0333	+0.0315	+1.5	22.6462	54.018
P. B. M. 4	....	138.70	....	....	....	+1.5	22.6462	54.018
T. B. M. 27	0.29	138.99	+0.0447	+0.0396	+0.0421	+1.5	22.6883	54.156
P. B. M. 3	0.04	139.03	−0.9020	−0.9016	−0.9018	+1.7	21.7867	51.198

[a] At Monroe, La.

[b] At Riverton, La.

TABLE 1 D.—*Precise levels, etc.—Tabulated results*—Continued.

MONROE TO MOUTH OF BLACK RIVER, LOUISIANA—Continued.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Monroe.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Milimeters.*	*Meters.*	*Feet.*
P.B.M.4	....	138.70	....	....	....	+1.5	22.6462	54.018
T.B.M.28	−0.68	138.02	−0.0288	−0.0230	−0.0259	+1.5	22.6203	53.933
P.B.M.5	0.02	138.04	−0.0893	−0.0903	−0.0898	+1.7	22.5305	53.638
P.B.M.4	....	138.70	....	....	....	+1.5	22.6462	54.018
T.B.M.1	1.98	140.68	+0.3097	+0.3267	+0.3182	+1.5	22.8679	54.745
T.B.M.2	1.60	142.28	+0.3326	+0.3312	+0.3319	+1.4	23.1997	55.834
T.B.M.3	1.83	144.11	+0.0335	+0.0391	+0.0363	+1.4	23.2360	55.953
T.B.M.4	1.55	145.66	+0.5909	+0.5909	+0.5909	+1.3	23.8268	57.891
P.B.M.5a, P.R.P.Jones	1.72	147.38	+0.3140	+0.3152	+0.3146	+1.2	24.1413	58.923
T.B.M.6	1.61	148.99	−0.4297	−0.4331	−0.4314	+1.3	23.7100	57.508
T.B.M.7	1.67	150.66	−0.0320	−0.0322	−0.0321	+1.3	23.6779	57.402
T.B.M.8	1.72	152.38	−0.3261	−0.3200	−0.3231	+1.4	23.3549	56.343
P.B.M.6a	6.92	159.30	−0.1778	−0.1772	−0.1775	+1.4	23.1774	55.760
T.B.M.13	1.67	160.97	−0.6547	−0.6617	−0.6582	+1.5	22.5193	53.601
P.B.M.7a, P.R.P. Calhoun	0.00	160.97	−0.0030	−0.0036	−0.0033	+1.5	22.5160	53.590
T.B.M.14	1.52	162.49	−0.0673	−0.0605	−0.0639	+1.5	22.4521	53.381
T.B.M.15	1.54	164.03	−0.5530	−0.5572	−0.5551	+1.6	22.8971	54.841
T.B.M.16	1.83	165.86	+0.7440	+0.7473	+0.7457	+1.5	22.6427	54.006
P.B.M.8a	0.00	165.86	+0.0717	+0.0717	+0.0717	+1.5	22.7144	54.242
T.B.M.21	6.04	171.90	−0.2121	−0.2238	−0.2179	+1.5	22.4965	53.526
P.B.M.9a, P.R.P.Lum	0.00	171.90	−0.3784	−0.3790	−0.3787	+1.6	22.1179	52.284
T.B.M.25	5.91	177.81	−0.0570	−0.0738	−0.0654	+1.6	22.0525	52.070
P.B.M.10a	0.00	177.81	−0.0220	−0.0237	−0.0228	+1.6	22.0297	51.995
T.B.M.26	1.76	179.57	−1.5777	−1.5749	−1.5763	+1.9	20.4537	46.825
T.B.M.29	4.53	184.10	+1.5814	+1.5802	+1.5808	+1.6	22.0342	52.010
T.B.M.33	5.21	189.31	−0.6389	−0.6368	−0.6378	+1.7	21.3965	49.918
P.B.M.11a, P.R.P.Acme	0.00	189.31	+0.0934	+0.0933	+0.0933	+1.7	21.4898	50.224
T.B.M.34	1.43	190.74	+0.1645	+0.1673	+0.1659	+1.7	21.6557	50.768
T.B.M.36	2.06	192.80	−0.5371	−0.5451	−0.5411	+1.8	21.1147	48.993
Discharge jar, L. B. Red River	0.00	192.80	+0.3826	+0.3827	+0.3826	+1.7	21.4972	50.248
Discharge jar, L. B. Black River	0.00	192.80	+0.1537	+0.1539	+0.1538	+1.7	21.6510	50.753
P.B.M.12a, P.R.P.Delhoste	0.00	192.80	−0.5391	−0.5392	−0.5391	+1.8	21.1120	48.984
R.R.S. △ 439	0.19	192.99	−0.4842	−0.4847	−0.4845	+1.9	20.6276	47.395

P. B. M. 27 is used as initial bench.

Levels run along dirt road by Walter H. Polk.

From P. B. M. 27 to P. B. M. 4 was run between December 28, 1893, and February 2, 1894.

From P. B. M. 4 to R. R. S. △ 439 was run between September 24 and November 13, 1894.

Elevation of P. B. M. 12a by run from Barbin Landing to mouth of Black River, La., 21.2129 meters, Cairo datum.

CAMDEN, ARK., TO SHREVEPORT, LA.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Camden.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
P.B.M. Camden IV	....	0.00	....	....	....	± 0.0	41.2473	115.044
P.R.P. Camden III	0.27	0.27	− 2.2517	− 2.2506	− 2.2512	+ 0.5	38.9966	107.660
T.B.M.201	0.96	1.23	+ 9.2387	+ 9.2417	+ 9.2402	− 1.6	48.2347	137.968
T.B.M.202	1.67	2.90	− 2.2869	− 2.2883	− 2.2876	− 1.1	45.9476	130.465
T.B.M.203	2.37	5.27	− 6.6072	− 6.6109	− 6.6090	+ 0.4	39.3401	108.787
T.B.M.204	1.21	6.48	+ 4.0222	+ 4.0240	+ 4.0231	− 0.5	43.3623	121.983
T.B.M.205	1.92	8.40	+ 0.9017	+ 0.8958	+ 0.8988	− 0.7	44.2609	124.931
T.B.M.206	1.37	9.77	+13.8182	+13.8130	+13.8156	− 3.8	58.0734	170.247
T.B.M.207	2.46	12.23	− 8.4998	− 8.4995	− 8.4997	− 1.9	49.5756	142.368
T.B.M.208	1.39	13.62	+ 2.1363	+ 2.1368	+ 2.1365	− 2.3	51.7117	149.376
T.B.M.209	2.53	16.15	+11.3827	+11.3858	+11.3842	− 4.9	63.0933	186.717
T.B.M.210	1.71	17.86	+13.1333	+13.1278	+13.1306	− 7.8	76.2210	229.786
U.S. Geological B. M	2.02	19.88	+17.6293	+17.6288	+17.6291	−11.8	93.8461	287.610
P.B.M. Buena Vista	0.13	20.01	− 1.6500	− 1.6483	− 1.6492	−11.4	92.1973	282.201
T.B.M.211	1.42	21.43	+ 3.3325	+ 3.3278	+ 3.3302	−12.2	95.5267	293.123
T.B.M.212	2.13	23.56	− 4.8703	− 4.8650	− 4.8677	−11.0	90.6602	277.158
T.B.M.213	1.74	25.30	−13.6111	−13.6168	−13.6139	− 8.0	77.0493	232.504
T.B.M.214	1.65	26.95	−13.5575	−13.5557	−13.5566	− 5.0	63.4957	188.037

TABLE 1 D.—*Precise levels, etc.—Tabulated results*—Continued.

CAMDEN, ARK., TO SHREVEPORT, LA.—Continued.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Camden.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
T. B. M. 214	....	26.95	....	....	....	− 5.0	63.4957	188.037
R. R. B. M	0.00	26.95	+ 0.2543	....	+ 0.2543	− 5.0	63.7500	188.871
T. B. M. 214	....	26.95	....	....	....	− 5.0	63.4957	188.037
T. B. M. 217	7.30	34.25	+13.9032	+13.8981	+13.9007	− 8.1	77.3933	233.632
P. B. M. Stephen	0.03	34.28	+ 0.6183	+ 0.6180	+ 0.6182	− 8.2	78.0114	235.660
T. B. M. 218	2.25	36.53	−16.2005	−16.2018	−16.2012	− 4.6	61.8138	182.519
T. B. M. 218	....	36.53	....	....	....	− 4.6	61.8138	182.519
R. R. B. M	0.00	36.53	+ 0.5000	....	+ 0.5000	− 4.7	62.3137	184.159
T. B. M. 218	....	36.53	....	....	....	− 4.6	61.8138	182.519
T. B. M. 219	2.77	39.30	+ 3.4325	+ 3.4255	+ 3.4290	− 5.4	65.2420	193.766
T. B. M. 220	2.56	41.86	+ 5.4466	+ 5.4402	+ 5.4434	− 6.6	70.6842	211.621
T. B. M. 221	0.72	42.58	+ 2.3070	+ 2.3082	+ 2.3076	− 7.1	72.9913	219.190
T. B. M. 222	2.62	45.20	+ 9.8690	+ 9.8695	+ 9.8692	− 9.3	82.8583	251.562
T. B. M. 223	2.52	47.72	+15.7788	+15.7767	+15.7777	−12.9	98.6324	303.314
T. B. M. 224	3.07	50.79	+ 6.3428	+ 6.3425	+ 6.3427	−14.3	104.9737	324.118
P. B. M. McNeil	0.02	50.81	− 0.5545	− 0.5553	− 0.5549	−14.2	104.4189	322.298
T. B. M. 225	3.26	54.07	− 7.2385	− 7.2414	− 7.2399	−12.5	97.1807	298.551
T. B. M. 226	2.11	56.18	+ 3.0552	+ 3.0528	+ 3.0540	−13.2	100.2340	308.568
T. B. M. 227	2.54	58.72	+14.1235	+14.1173	+14.1204	−16.4	114.3512	354.884
P. B. M. Waldo	0.01	58.73	− 0.8710	− 0.8717	− 0.8713	−16.2	113.4801	352.025
T. B. M. 229	5.12	63.85	−14.6204	−14.6216	−14.6210	−12.9	98.8624	304.068
T. B. M. 229	....	63.85	....	....	....	−12.9	98.8624	304.068
R. R. B. M	0.00	63.85	+ 0.1410	....	+ 0.1410	−12.9	99.0034	304.531
T. B. M. 229	....	63.85	....	....	....	−12.9	98.8624	304.068
T. B. M. 231	4.45	68.30	− 8.3787	− 8.3715	− 8.3751	−11.0	90.4892	276.597
T. B. M. 232	2.12	70.42	− 9.4942	− 9.4985	− 9.4963	− 8.9	80.9950	245.448
T. B. M. 232	....	70.42	....	....	....	− 8.9	80.9950	245.448
R. R. B. M	0.06	70.48	+ 0.6376	+ 0.6365	+ 0.6370	− 9.0	81.6319	247.587
T. B. M. 232	....	70.42	....	....	....	− 8.9	80.9950	245.448
T. B. M. 233	3.22	73.64	+13.3365	+13.3322	+13.3343	−11.9	94.3263	289.186
T. B. M. 234	1.68	75.32	− 2.0403	− 2.0444	− 2.0424	−11.4	92.2844	282.487
T. B. M. 235	2.21	77.53	− 3.0427	− 3.0398	− 3.0412	−10.8	89.2438	272.511
P. B. M. Stamp	0.02	77.55	− 1.6200	− 1.6205	− 1.6203	−10.4	87.6239	267.195
T. B. M. 236	1.77	79.32	− 3.5993	− 3.5975	− 3.5984	− 9.6	84.0263	255.394
T. B. M. 237	3.30	82.62	+ 7.0637	+ 7.0643	+ 7.0640	−11.2	91.0887	278.564
T. B. M. 238	2.73	85.35	− 4.8086	− 4.8035	− 4.8060	−10.1	86.2838	262.800
P. B. M. Lewisville	0.03	85.38	− 0.9007	− 0.9000	− 0.9003	− 9.9	85.3837	259.847
T. B. M. 239	0.90	86.28	+ 4.5570	+ 4.5587	+ 4.5578	−10.9	89.9405	274.797
T. B. M. 239	....	86.28	....	....	....	−10.9	89.9405	274.797
T. B. M. 239 B	5.05	91.33	−15.1455	−15.1401	−15.1429	− 7.5	74.8010	225.127
Gauge B. M. A	6.22	97.55	+ 1.4434	+ 1.4383	+ 1.4408	− 7.8	76.2415	229.858
P. B. M. Garland	0.18	97.73	+ 0.4710	+ 0.4707	+ 0.4708	− 7.9	76.7122	231.397
Red River survey B. M. 4	0.35	98.08	− 0.2135	− 0.2118	− 0.2127	− 7.9	76.4995	230.699
T. B. M. 239	....	86.28	....	....	....	−10.9	89.9405	274.797
T. B. M. 240	1.88	88.16	− 2.0283	− 2.0283	− 2.0283	−10.4	87.9127	268.145
T. B. M. 241	2.18	90.34	+ 0.4867	+ 0.4818	+ 0.4843	−10.5	88.3969	269.733
T. B. M. 242	2.85	93.19	− 0.6218	− 0.6157	− 0.6188	−10.4	87.7782	267.703
T. B. M. 243	2.00	95.19	− 4.7620	− 4.7617	− 4.7618	− 9.4	83.0174	252.084
T. B. M. 244	3.12	98.31	− 2.7988	− 2.7917	− 2.7953	− 8.7	80.2228	242.915
T. B. M. 245	2.41	100.72	+ 4.6140	+ 4.6193	+ 4.6167	− 9.8	84.8384	258.058
T. B. M. 246	2.12	102.84	+ 0.8737	+ 0.8737	+ 0.8737	−10.0	85.7119	260.924
T. B. M. 247	1.09	103.93	− 0.4973	− 0.5010	− 0.4992	− 9.8	85.2129	259.286
T. B. M. 248	1.82	105.75	+ 0.6293	+ 0.6267	+ 0.6280	−10.0	85.8407	261.347
T. B. M. 248	....	105.75	....	....	....	−10.0	85.8407	261.347
T. B. M. 248 B	4.02	109.77	− 4.2013	− 4.2090	− 4.2051	− 9.0	81.6366	247.554
T. B. M. 248 C	1.02	110.79	+ 5.1162	+ 5.1155	+ 5.1158	−10.2	86.7512	264.333
T. B. M. 248 D	1.31	112.13	+ 0.5755	+ 0.5710	+ 0.5732	−10.3	87.3243	266.214
T. B. M. 248 E	2.24	114.37	−15.0078	−15.0117	−15.0097	− 7.0	72.3179	216.980
T. B. M. 248 F	2.76	117.13	+ 0.3942	+ 0.4007	+ 0.3974	− 7.0	72.7153	218.284
P. B. M. Jordan	0.03	117.16	− 0.8398	− 0.8403	− 0.8400	− 6.9	71.8754	215.528
Red River survey P. R. P. 14	0.14	117.30	+ 0.0911	+ 0.0933	+ 0.0922	− 6.9	71.9676	215.832
T. B. M. 248	....	105.75	....	....	....	−10.0	85.8407	261.347
P. B. M. Canfield	0.02	105.77	− 0.8277	0.8273	− 0.8275	− 9.8	85.0134	258.632
T. B. M. 249	3.18	108.95	− 0.4101	− 0.4122	− 0.4112	− 9.7	84.6023	257.284

TABLE 1 D.—*Precise levels, etc.—Tabulated results*—Continued.

CAMDEN, ARK., TO SHREVEPORT, LA.—Continued.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Camden.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
T. B. M. 250	3.21	112.16	- 2.4807	- 2.4812	- 2.4809	- 9.2	82.1219	249.146
T. B. M. 251	3.22	115.38	+ 1.4068	+ 1.4043	+ 1.4056	- 9.5	83.5272	253.756
P. B. M. Bradley	0.08	115.46	- 0.3927	- 0.3923	- 0.3925	- 9.4	83.1348	252.469
T. B. M. 252	1.57	117.03	- 0.0721	- 0.0744	- 0.0733	- 9.4	83.0615	252.228
T. B. M. 253	2.21	119.24	+ 0.2307	+ 0.2365	+ 0.2336	- 9.4	83.2951	252.994
T. B. M. 254	2.50	121.74	- 2.2327	- 2.2250	- 2.2288	- 8.9	81.0668	245.684
T. B. M. 255	2.58	124.32	- 0.0493	- 0.0424	- 0.0459	- 8.9	81.0209	245.534
T. B. M. 256	1.06	125.38	- 0.4329	- 0.4372	- 0.4350	- 8.8	80.5860	244.107
T. B. M. 257	1.50	126.88	+ 1.3502	+ 1.3521	+ 1.3511	- 9.1	81.9368	248.538
T. B. M. 258	2.48	129.36	+22.0415	+22.0453	+22.0434	-14.0	103.9753	320.842
T. B. M. 259	2.43	131.79	+ 5.6905	+ 5.6883	+ 5.6894	-15.3	109.6634	339.504
T. B. M. 260	2.92	134.71	- 2.2828	- 2.2832	- 2.2830	-14.8	107.3809	332.015
T. B. M. 261	2.58	137.29	-20.9687	-20.9713	-20.9700	-10.1	86.4156	263.232
T. B. M. 261	....	137.29	....	....	....	-10.1	86.4156	263.232
T. B. M. 261A	1.76	139.05	+17.9197	+17.9132	+17.9165	-14.1	104.3281	321.999
T. B. M. 261B	1.40	140.45	+12.5545	+12.5503	+12.5524	-16.9	116.8777	363.173
T. B. M. 261C	1.34	141.79	+ 4.7918	+ 4.7922	+ 4.7920	-18.0	121.6686	378.891
T. B. M. 261D	1.03	142.82	-16.1017	-16.1078	-16.1047	-14.4	105.5675	326.066
T. B. M. 261E	1.28	144.10	- 3.4774	- 3.4799	- 3.4787	-13.6	102.0896	314.656
T. B. M. 261F	1.31	145.41	+ 4.5201	+ 4.5197	+ 4.5199	-14.6	106.6085	329.482
T. B. M. 261H	2.17	147.58	- 2.3765	- 2.3862	- 2.3814	-14.1	104.2276	321.670
T. B. M. 261I	0.92	148.50	-27.5203	-27.5210	-27.5206	- 7.9	76.7132	231.401
P. B. M. Lusk	0.03	148.53	- 0.6900	- 0.6893	- 0.6897	- 7.8	76.0236	229.139
Red River survey P. R. P. 25	1.00	149.53	- 9.4143	- 9.4178	- 9.4160	- 5.7	66.6097	198.254
T. B. M. 261	....	137.29	....	....	....	-10.1	86.4156	263.052
P. B. M. Plain Dealing	0.03	137.32	- 0.8592	- 0.8593	- 0.8592	- 9.9	85.5566	260.415
T. B. M. 262	2.97	140.29	- 1.4243	- 1.4305	- 1.4274	- 9.6	84.1295	255.732
T. B. M. 263	2.35	142.64	- 4.4177	- 4.4150	- 4.4163	- 8.6	79.7142	241.246
T. B. M. 264	2.97	145.61	-10.4657	-10.4607	-10.4632	- 6.3	69.2533	206.926
T. B. M. 265	2.78	148.39	+ 3.8495	+ 3.8495	+ 3.8495	- 7.1	73.1020	219.553
T. B. M. 267	4.16	152.55	- 0.5450	- 0.5487	- 0.5468	- 7.0	72.5553	217.759
P. B. M. Alden Bridge	0.05	152.60	- 0.6823	- 0.6828	- 0.6826	- 6.9	71.8728	215.521
T. B. M. 268	2.09	154.69	- 0.9329	- 0.9282	- 0.9305	- 6.6	70.9426	212.468
T. B. M. 269	3.16	157.85	+ 0.2733	+ 0.2697	+ 0.2715	- 6.7	71.2140	213.359
T. B. M. 270	3.16	161.01	+ 0.4020	+ 0.4022	+ 0.4021	- 6.8	71.6160	214.678
T. B. M. 270	....	161.01	....	....	....	- 6.8	71.6160	214.678
T. B. M. 270A	2.63	163.64	+13.6343	+13.6275	+13.6309	- 9.9	85.2438	259.388
T. B. M. 270B	1.09	164.73	-12.2568	-12.2582	-12.2575	- 7.1	72.9891	219.184
T. B. M. 270C	2.13	166.86	- 7.7577	- 7.7615	- 7.7596	- 5.4	65.2312	193.730
P. B. M. Hurricane Bluff	0.06	166.92	- 0.6795	- 0.6810	- 0.6802	- 5.2	64.5512	191.500
Red River survey P. R. P. 30C	0.23	167.15	+11.3718	+11.3738	+11.3728	- 7.8	75.9214	228.803
T. B. M. 270	....	161.01	....	....	....	- 6.8	71.6160	214.678
P. B. M. Benton	0.31	161.32	- 1.4070	- 1.4045	- 1.4058	- 6.5	70.2105	210.067
T. B. M. 271	2.40	163.72	- 8.0433	- 8.0503	- 8.0468	- 4.7	62.1655	183.673
T. B. M. 273	4.86	168.58	- 1.6287	- 1.6322	- 1.6304	- 4.3	60.5355	178.325
T. B. M. 274	1.93	170.51	- 0.1605	- 0.1583	- 0.1594	- 4.3	60.3761	177.802
Red River survey P. R. P. 32	2.00	172.51	+ 1.1981	+ 1.2026	+ 1.2003	- 4.6	61.5761	181.739
T. B. M. 276	1.73	174.24	- 2.8758	- 2.8711	- 2.8734	- 3.9	58.7034	172.314
T. B. M. 277	2.12	176.36	+ 0.1747	+ 0.1757	+ 0.1752	- 3.9	58.8786	172.889
P. B. M. 45	5.82	182.18	- 0.5500	- 0.5472	- 0.5486	- 3.8	58.3301	171.090
B. M. "B. P."	0.47	182.65	+ 4.6460	+ 4.6469	+ 4.6464	- 4.9	62.9754	186.330
P. B. M. 46	0.84	183.44	+ 2.8213	+ 2.8218	+ 2.8216	- 5.5	65.7964	195.585

P. B. M. Camden IV is used as initial bench. (See tabulated results, Monroe, La., to Little Rock, Ark., p. 15.)

Levels run along St. Louis Southwestern Railway track by Walter H. Polk, May 7 to July 17, 1900.

Elevation of P. B. M. 46 by run from Delta to Shreveport, La., 65.8447 meters, Cairo datum.

TABLE 1 D.—*Precise levels, etc.—Tabulated results*—**Continued.**

PARKEVILLE, LA., TO GREENVILLE, MISS., VIA ARKANSAS CITY, ARK.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Parkeville.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
P. R. P. Parkeville	....	0.00	....	....	....	....	29.7302	77.259
T. B. M. 74 (1895)	0.01	0.01	+1.2233	+1.2220	+1.2226	−0.2	30.9526	81.269
T. B. M. 20	2.43	2.44	+1.8478	+1.8494	+1.8486	−0.4	32.8010	87.334
P. R. P. Sandidge	0.00	2.44	+0.5433	+0.5423	+0.5428	−0.5	33.3437	89.114
T. B. M. 21	1.83	4.27	−1.8293	−1.8291	−1.8292	−0.2	31.5148	83.114
P. R. P. Myers	2.98	7.25	+2.3132	+2.3140	+2.3136	−0.5	33.8281	90.708
T. B. M. 27	5.87	13.12	−1.1475	−1.1528	−1.1502	−0.4	32.6780	86.930
P. R. P. Williams	0.00	13.12	−0.0877	−0.0883	−0.0880	−0.4	32.5900	86.641
T. B. M. 28	1.71	14.83	+1.0980	+1.0973	+1.0977	−0.5	33.6876	90.242
P. R. P. Anderson	0.00	14.83	−0.0040	−0.0053	−0.0046	−0.5	33.6830	90.227
P. R. P. Bonner	6.65	21.48	+0.4648	+0.4818	+0.4733	−0.6	34.1562	91.780
T. B. M. 33	1.70	23.18	+0.7310	+0.7325	+0.7318	−0.7	34.8879	94.180
T. B. M. 35	4.32	27.50	+0.1970	+0.2042	+0.2006	−0.7	35.0885	94.838
T. B. M. 36	1.52	29.02	+0.2832	+0.2860	+0.2846	−0.8	35.3730	95.772
P. R. P. Davis, "2"	0.00	29.02	−0.0212	−0.0209	−0.0211	−0.8	35.3519	95.703
T. B. M. 37	2.26	31.28	−0.5731	−0.5716	−0.5723	0.7	34.7797	93.825
T. B. M. 38	1.93	33.21	+0.1758	+0.1795	+0.1777	−0.7	34.9574	94.408
P. R. P. Ward	0.00	33.21	+0.8190	+0.8193	+0.8192	−0.8	35.7765	97.096
T. B. M. 41	5.17	38.38	+0.2232	+0.2177	+0.2204	−0.8	35.9969	97.819
T. B. M. 43	3.41	41.79	+0.7596	+0.7593	+0.7595	−0.9	36.7563	100.310
P. R. P. Wells	0.00	41.79	−0.1203	−0.1213	−0.1208	−0.9	36.6355	99.914
T. B. M. 46	4.70	46.49	+1.0772	+1.0801	+1.0787	−1.1	37.7140	103.453
P. R. P. Mound	0.00	46.49	−0.3530	−0.3530	−0.3530	−1.0	37.3611	102.294
T. B. M. 49	5.48	51.97	−0.9168	−0.9148	−0.9158	−0.9	36.4454	99.290
T. B. M. 50	2.10	54.07	+1.6716	+1.6725	+1.6720	−1.1	38.1172	104.775
P. R. P. Lindgrove	0.00	54.07	+0.2618	+0.2618	+0.2618	−1.2	38.3789	105.634
T. B. M. 51	2.05	56.12	−0.7908	−0.7905	−0.7906	−1.1	37.5884	103.040
T. B. M. 52	2.15	58.27	−3.0025	−3.0054	−3.0040	−0.7	34.5848	93.186
T. B. M. 53	1.18	59.45	+3.7335	+3.7315	+3.7325	−1.2	38.3168	105.430
P. B. M. Bonita	0.00	59.45	+0.2670	+0.2682	+0.2676	−1.2	38.5844	106.308
T. B. M. 54	3.43	62.88	−1.6728	−1.6812	−1.6770	−1.0	36.9076	100.806
T. B. M. 55	0.78	63.66	+0.1792	+0.1787	+0.1789	−1.0	37.0865	101.393
T. B. M. 56	2.21	65.87	+1.4767	+1.4794	+1.4780	−1.2	38.5643	106.242
P. B. M. Jones	0.00	65.87	+0.1425	+0.1423	+0.1424	−1.2	38.7067	106.709
T. B. M. 57	2.51	68.38	−0.8208	−0.8148	−0.8178	−1.1	37.8890	104.026
T. B. M. 58	1.72	70.10	+0.7368	+0.7428	+0.7398	−1.2	38.6287	106.453
P. R. P. La.-Ark	0.00	70.10	+0.1900	+0.1893	+0.1897	1.2	38 8184	107.075
T. B. M. 59	2.27	72.37	−0.0266	−0.0186	−0.0226	−1.2	38.7958	107.002
T. B. M. 60	1.28	73.65	−0.6069	−0.6074	−0.6072	−1.1	38.1887	105.010
T. B. M. 61	1.70	75.35	+0.4238	+0.4263	+0.4251	−1.2	38.6137	106.404
T. B. M. 62	1.67	77.02	+0.7205	+0.7227	+0.7216	−1.3	39.3352	108.771
T. B. M. 63	1.70	78.72	+1.5483	+1.5443	+1.5463	−1.5	40.8813	113.843
P. B. M. Wilmot	0.00	78.72	+0.1594	+0.1594	+0.1594	−1.5	41.0407	114.367
T. B. M. 64	1.89	80.61	−1.4915	−1.4864	−1.4889	−1.3	39.5520	109.482
T. B. M. 65	1.92	82.53	+0.8905	+0.8909	+0.8907	−1.4	40.4426	112.404
T. B. M. 66	1.97	83.50	+0.3239	+0.3232	+0.3236	−1.5	40.7661	113.465
P. R. P. Noble "1"	0.00	83.50	+0.0922	+0.0913	+0.0917	−1.5	40.8578	113.766
T. B. M. 67	1.80	85.30	+0.3846	+0.3829	+0.3838	−1.5	41.2416	115.026
Gauge B. M. D	0.00	85.30	+1.0775	+1.0754	+1.0764	−1.7	42.3178	118.556
P. B. M. Parkdale	0.57	85.87	−0.6529	−0.6507	−0.6518	−1.6	41.6661	116.418
T. B. M. 69	1.73	87.60	+0.3114	+0.3114	+0.3114	−1.6	41.9775	117.440
T. B. M. 70	1.72	89.32	+0.1814	+0.1877	+0.1846	−1.7	42.1620	118.045
T. B. M. 71	1.84	91.16	+0.0522	+0.0507	+0.0514	−1.7	42.2134	118.212
T. B. M. 72	1.67	92.83	−0.8935	−0.8934	−0.8935	−1.6	41.3200	115.282
P. B. M. Sunshine	0.64	93.47	+0.8183	+0.8189	+0.8186	−1.7	42.1385	117.967
T. B. M. 74	1.79	95.26	1.5718	−1.5711	−1.5715	−1.5	40.5672	112.813
T. B. M. 76	4.00	99.26	+3.2674	+3.2774	+3.2724	−1.9	43.8392	123.548
P. B. M. Portland	0.48	99.74	+1.1893	+1.1894	+1.1893	−2.1	45.0283	127.449
T. B. M. 78	1.70	101.44	1.4877	−1.4818	−1.4848	−1.9	43.5437	122.578
T. B. M. 79	1.16	102.60	+0.3927	+0.3954	+0.3941	−1.9	43.9378	123.871
T. B. M. 80	1.79	104.39	−0.1933	−0.1933	−0.1933	−1.9	43.7445	123.237
T. B. M. 81	1.74	106.13	−0.5492	−0.5458	−0.5475	−1.8	43.1971	121.441
T. B. M. 82	1.70	107.83	+0.1747	+0.1810	+0.1778	−1.8	43.3749	122.024
T. B. M. 83	0.69	108.52	+0.8712	+0.8715	+0.8713	−1.9	44.2461	124.883
P. B. M. Kidd	0.00	108.52	−0.1966	0.1972	−0.1969	−1.9	44.0492	124.237
T. B. M. 84	1.73	110.25	+1.3460	+1.3497	+1.3479	−2.1	45.3969	128.658
T. B. M. 85	1.14	111.39	−0.6198	−0.6175	−0.6187	−2.0	44.7783	126.629
T. B. M. 86	1.01	112.40	−0.4362	0.4372	−0.4367	−2.0	44.3416	125.193
T. B. M. 87	1.47	113.87	+1.4381	+1.4412	+1.4396	−2.2	45.7810	129.918
P. R. P. Morrell	0.57	114.42	+0.0545	+0.0576	+0.0561	−2.2	45.8371	130.102
T. B. M. 89	1.68	116.10	−1.3565	−1.3534	−1.3550	−2.0	44.4823	125.658
T. B. M. 90	1.36	117.46	+0.2689	+0.2731	+0.2710	−2.0	44.7533	126.547
T. B. M. 91	1.70	119.16	+0.8253	+0.8293	+0.8273	−2.1	45.5805	129.261
T. B. M. 92	1.59	120.75	−0.1560	−0.1532	−0.1546	−2.1	45.4259	128.753
T. B. M. 93	2.52	123.27	+1.0753	+1.0733	+1.0743	−2.2	46.5001	132.278
P. B. M. Hudspeth	0.00	123.27	+0.2007	+0.2010	+0.2008	−2.3	46.7008	132.936
T. B. M. 94	**2.66**	**125.93**	**+1.5048**	**+1.5082**	**+1.5065**	**−2.5**	**48.2071**	**137.878**

TABLE 1 D.—*Precise levels, etc.—Tabulated results*—Continued.

PARKEVILLE, LA., TO GREENVILLE, MISS., VIA ARKANSAS CITY, ARK.—Continued.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Parkeville.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
T. B. M. 95	1.34	127.27	−0.7443	−0.7397	−0.7420	−2.4	47.4652	135.444
T. B. M. 98	5.91	133.18	+0.4343	+0.4383	+0.4363	−2.4	47.9015	136.875
T. B. M. 98	....	133.18	....	....	....	−2.4	47.9015	136.875
P. B. M. Dermott	0.00	133.18	+0.9497	+0.9495	+0.9496	−2.6	48.8509	139.990
T. B. M. 99a	1.66	134.84	+0.4170	+0.4108	+0.4139	−2.6	49.2648	141.348
T. B. M. 100a	1.50	136.34	−1.3237	−1.3255	−1.3246	−2.4	47.9404	137.003
T. B. M. 101a	1.41	137.75	−1.1155	−1.1202	−1.1178	−2.3	46.8227	133.336
T. B. M 102a	1.72	139.47	+2.4015	+2.4015	+2.4015	−2.6	49.2239	141.214
P. R. P. Baxter	0.04	139.51	+0.1610	+0.1600	+0.1605	−2.6	49.3844	141.740
T. B. M. 98	....	133.18	....	....	....	−2.4	47.9015	136.875
T. B. M. 99	1.25	134.43	−0.1197	−0.1143	−0.1170	−2.4	47.7845	136.492
T. B. M. 100	1.66	136.09	−0.3553	−0.3545	−0.3549	−2.4	47.4296	135.327
T. B. M. 101	1.73	137.82	+0.3773	+0.3763	+0.3768	−2.4	47.8064	136.563
T. B. M. 102	1.56	139.38	+0.4369	+0.4400	+0.4385	−2.5	48.2448	138.002
T. B. M. 103	1.63	141.01	+0.8217	+0.8218	+0.8218	−2.6	49.0665	140.698
T. B. M. 104	1.37	142.38	−0.7790	−0.7822	−0.7806	−2.5	48.2860	138.135
T. B. M. 105	1.63	144.01	+2.7358	+2.7363	+2.7361	−2.9	51.0217	147.112
T. B. M. 106a	1.31	145.32	+0.2632	+0.2645	+0.2638	−2.9	51.2855	147.977
P. B. M. G. (C. and G. S.)	0.00	145.32	+0.4860	+0.4843	+0.4852	−3.0	51.7706	149.569
P. B. M. McGehee	0.00	145.32	−0.3230	−0.3213	−0.3222	−2.9	51.4485	148.513
T. B. M. 107	1.26	146.58	−0.8740	−0.8768	−0.8754	−2.8	50.5732	145.641
T. B. M. 108	1.12	147.70	−0.9343	−0.9330	−0.9337	−2.7	49.6396	142.578
T. B. M. 109	1.01	148.71	−1.8743	−1.8709	−1.8726	−2.4	47.7673	136.435
T. B. M. 110	1.41	150.12	−0.1592	−0.1627	−0.1609	−2.4	47.6064	135.908
P. B. M. Trippe	0.00	150.12	+2.6260	+2.6263	+2.6262	−2.7	50.2323	144.522
T. B. M. 117	11.13	161.25	+0.0109	+0.0166	+0.0138	−2.7	50.2461	144.567
P. B. M. F. (C. and G. S.)	0.00	161.25	−1.8640	−1.8620	−1.8630	−2.5	48.3833	138.457
B. M. A. (Ewens)	0.00	161.25	−0.0897	−0.0910	−0.0903	−2.5	48.2930	138.160
Stone $\frac{63}{3}$ (M. R. C.)	0.00	161.25	−0.6526	−0.6515	−0.6521	−2.4	47.6410	136.021
Stone $\frac{63}{2}$ (M. R. C.)	1.83	163.08	+2.6830	+2.6807	+2.6819	−2.8	50.3225	144.817
P. B. M. 84 (M. R. C.)	0.00	163.08	−1.8850	−1.8853	−1.8852	−2.5	48.4376	138.634
T. B. M. 120	4.42	167.50	−1.0051	−1.0052	−1.0051	−2.4	47.4326	135.337
P. B. M. 85 (M. R. C.)	1.15	168.65	+0.3542	+0.3590	+0.3566	−2.4	47.7892	136.507
T. B. M. 121	0.94	169.59	+2.4592	+2.4604	+2.4598	−2.7	50.2487	144.576
P. B. M. 86 (M. R. C.)	1.13	170.72	−2.9471	−2.9428	−2.9450	−2.4	47.3040	134.915
T. B. M. 122	1.31	172.03	+2.4877	+2.4933	+2.4905	−2.7	49.7942	143.084
P. B. M. Millers Bend	11.91	183.94	−4.9419	−4.9561	−4.9490	−2.0	44.8459	126.851
T. B. M. 139	10.99	194.93	−0.3580	−0.3595	−0.3588	−2.0	44.4871	125.673
B. M. O. (M. R. C.)	1.45	196.38	−0.2070	−0.2122	−0.2096	−1.9	44.2776	124.986
P. B. M. Greenville, No. 1 (C. and G. S.)	−0.05	196.33	+1.8567	+1.8574	+1.8570	−2.2	46.1343	131.077

P. R. P. Parkeville is used as initial bench. (See tabulated results, Monroe, La., to Little Rock, Ark. p. 14.)

From P. R. P. Parkeville to P. B. M. Bonita was run along dirt road; from P. B. M. Bonita to C. and G. S. P. B. M. F. was run along railway tracks; from P. B. M. F. to M. R. C. stone $\frac{63}{2}$ was crossing of Mississippi River to levee, and from M. R. C. stone $\frac{63}{2}$ to P. B. M. Greenville No. 1 was run along top of levees.

Lines were run by Walter H. Polk, June 10 to October 25, 1897.

Elevation of P. B. M. Greenville No. 1 by line from Delta, La., to Greenville, Miss., via Yazoo City, Miss., 46.2359 meters, Cairo datum.

Elevation of P. B. M. Greenville No. 1 by U. S. Coast and Geodetic Survey, 131.111 feet, Gulf level. (See their report, 1898–99, Appendix 8, p. 483.)

GLENDORA TO FARMERVILLE AND STEINS BLUFF, LA.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Glendora.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
T. B. M. 79	....	− 0.47	....	....	....	....	32.2192	85.425
P. R. P. Glendora	0.47	0.00	− 1.3260	− 1.3270	− 1.3265	+0.3	30.8930	81.074
T. B. M. 29	2.03	2.03	− 0.7306	− 0.7247	− 0.7277	+0.5	30.1655	78.687
P. B. M. Port Union	1.41	3.44	+ 1.7932	+ 1.7929	+ 1.7931	+0.1	31.9582	84.569
T. B. M. 28	0.58	4.02	− 0.8985	− 0.8950	− 0.8968	+0.3	31.0616	81.627
T. B. M. 27	1.39	5.41	− 1.1709	1.1718	− 1.1713	+0.5	29.8905	77.785
T. B. M. 26	1.35	6.76	+ 6.0839	+ 6.0814	+ 6.0827	−0.8	35.9719	97.737

TABLE 1 D.—*Precise levels, etc.—Tabulated results*—Contiuued.

GLENDORA TO FARMERSVILLE AND STEINS BLUFF, LA.—Continued.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Glendora.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
P. B. M. Hay	1.22	7.98	+11.4116	+11.4149	+11.4132	−3.4	47.3825	135.173
T. B. M. 25	2.10	10.08	+ 4.2258	+ 4.2239	+ 4.2249	−4.3	51.6065	149.031
T. B. M. 24	1.03	11.11	+ 2.3484	+ 2.3525	+ 2.3504	−4.9	53.9563	156.740
T. B. M. 23	0.92	12.03	+ 3.4922	+ 3.4943	+ 3.4932	−5.6	57.4488	168.198
T. B. M. 22	1.18	13.21	+ 4.2334	+ 4.2354	+ 4.2344	−6.6	61.6822	182.087
T. B. M. 21	1.72	14.93	− 9.0871	− 9.0826	− 9.0848	−4.6	52.5994	152.288
P. B. M. White	1.39	16.32	+ 8.1552	+ 8.1599	+ 8.1576	−6.4	60.7552	179.045
T. B. M. 20	1.73	18.05	− 1.9481	− 1.9451	− 1.9466	−6.0	58.8090	172.661
T. B. M. 19	1.41	19.46	− 5.2561	− 5.2527	− 5.2544	−4.8	53.5558	155.426
T. B. M. 18	1.16	20.62	−13.5912	−13.5868	−13.5890	−1.7	39.9699	110.853
T. B. M. 17	0.97	21.59	+21.5029	+21.5024	+21.5026	−6.6	61.4676	181.383
P. B. M. Rogers	1.06	22.65	− 1.8355	− 1.8310	− 1.8332	−6.1	59.6349	175.370
T. B. M. 16	1.28	23.93	+ 1.7478	+ 1.7535	+ 1.7506	−6.5	61.3851	181.112
T. B. M. 15	1.07	25.00	−31.9717	−31.9700	−31.9708	+0.6	29.4214	76.246
T. B. M. 14	1.26	26.26	+12.9230	+12.9213	+12.9221	−2.3	42.3406	118.631
T. B. M. 11	3.58	29.84	+14.7518	+14.7560	+14.7539	−5.6	57.0912	167.025
T. B. M. 10	1.38	31.22	−21.1917	−21.1930	−21.1923	−0.8	35.9037	97.513
T. B. M. 9	1.01	32.23	+10.2971	+10.3004	+10.2987	−3.1	46.2001	131.293
T. B. M. 8	1.19	33.42	− 3.9838	− 3.9788	− 3.9813	−2.2	42.2197	118.235
T. B. M. 7	1.15	34.57	+10.6876	+10.6894	+10.6885	−4.6	52.9058	153.293
P. B. M. Farmerville	1.05	35.62	+ 7.9747	+ 7.9795	+ 7.9771	−6.4	60.8811	179.459
T. B. M. 3	1.27	36.89	+ 5.3710	+ 5.3698	+ 5.3704	−7.6	66.2503	197.074
T. B. M. 4	0.99	37.88	−37.5863	−37.5910	−37.5886	+0.8	28.6701	73.781
T. B. M. 6	2.42	40.30	+12.9463	+12.9478	+12.9470	−2.1	41.6142	116.248
P. B. M. Scott	0.39	40.69	−12.3171	−12.3174	−12.3172	+0.6	29.2997	75.846
B. M. Scott	0.02	40.71	− 0.4070	− 0.4067	− 0.4068	+0.7	28.8930	74.512
P. B. M. Stein	1.59	42.30	+ 6.7309	+ 6.7258	+ 6.7283	−0.8	35.6198	96.582
B. M. Stein	0.03	42.33	− 4.1903	− 4.1920	− 4.1911	+0.2	31.4297	82.835
P. B. M. Farmerville	....	35.62	....	....	....	−6.4	60.8811	179.459
T. B. M. 1	0.88	36.50	+ 1.6710	+ 1.6691	+ 1.6700	−6.8	62.5507	184.936
B. M. Cox	3.16	39.66	−36.3428	−36.3473	−36.3450	+1.3	26.2138	65.722
B. M. L	0.01	39.67	− 0.1660	− 0.1660	− 0.1660	+1.4	26.0479	65.178
P. B. M. Cox Ferry	0.04	39.71	+ 1.6479	+ 1.6481	+ 1.6480	+1.0	27.6955	70.583

T. B. M. 79 is used as initial bench. (See tabulated results, Monroe, La., to Little Rock, Ark., p. 14.) Levels were run along dirt road by William R. Neely, December 8, 1897, to January 6, 1898.

DELTA TO COUSHATTA, LA.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Delta.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
P. B. M. 215 (C. and G. S.)	....	0.0	....	....	....	....	34.0836	91.542
△ SW base	0.1	0.1	−1.2435 −1.2459	−1.2496	−1.2463	+0.1	32.8374	87.453
P. B. M. 2	8.1	8.2	−1.3163	−1.3137	−1.3150	0.0	31.5223	83.138
P. B. M. 3	4.8	13.0	+1.5521	+1.5439	+1.5480	0.0	33.0703	88.217
P. B. M. 4	5.8	18.8	−2.1913	−2.1874	2.1909	+0.2	30.8796	81.030
P. B. M. 5	7.3	26.1	+3.2716	+3.2955	+3.2836	0.0	34.1630	91.802
P. B. M. 6	0.0	26.1	−0.3959	−0.3959	−0.3959	0.0	33.7671	90.503
P. B. M. 7	6.4	32.5	−4.0365	−4.0125	−4.0245	+0.5	29.7431	77.301
P. B. M. 8	5.4	37.9	−0.6895	−0.6681	−0.6788	−0.1	29.0637	75.072
P. B. M. 9	6.0	43.9	+0.9313	+0.9325	+0.9319	+0.2	29.9959	78.131
P. B. M. 10	0.0	43.9	−0.5879	0.5851	0.5865	+0.2	29.4094	76.206
P. B. M. 11	4.0	47.9	+0.7139	+0.7041	+0.7090	0.0	30.1182	78.532
P. B. M. 12	6.6	54.5	−1.3263	1.3089	1.3176	+0.6	28.8012	74.211
P. B. M. 13	1.0	55.5	+6.1282	+6.1241	+6.1261	−0.0	34.9267	94.307
B. M. Delhi	0.0	55.5	−0.2819	−0.2820	−0.2820	−0.0	34.6447	93.381
T. B. M. 30	5.3	60.8	−2.1298	−2.1315	−2.1306	+0.1	32.5142	86.393
P. B. M. 14	1.3	62.1	±0.0000	+0.0000	±0.0000	−0.1	32.5140	86.392
P. B. M. 15	7.2	69.3	−0.4377	−0.4122	−0.4250	+0.1	32.0892	84.998
P. B. M. 16	10.3	79.6	−1.4187	−1.4347	−1.4267	0.0	30.6624	80.317
P. B. M. 17	0.0	79.6	+2.3289	+2.3296	+2.3292	+0.1	32.9917	87.959
T. B. M. 39	2.7	82.3	−2.5500	−2.5401	−2.5450	+0.2	30.4468	79.610
T. B. M. 40a	3.3	85.6	+0.6488	+0.6430	+0.6459	+0.1	31.0926	81.729
P. B. M. 18	0.0	85.6	−0.5202	−0.5201	−0.5201	+0.2	30.5726	80.023

TABLE 1 D.—*Precise levels, etc.—Tabulated results*—Continued.

DELTA TO COUSHATTA, LA.—Continued.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Delta.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
P. B. M. 19	0.0	85.6	− 0.2512	− 0.2517	− 0.2515	0.0	30.3209	79.197
P. B. M. 20	0.0	85.6	+ 2.1417	+ 2.1421	+ 2.1419	+0.1	32.4629	86.224
T. B. M. 41a	2.4	88.0	− 2.3825	− 2.3841	− 2.3833	+0.1	30.0796	78.405
T. B. M. 42½	5.4	93.4	− 3.3437	− 3.3359	− 3.3398	+0.4	26.7401	67.449
P. B. M. 21	0.0	93.4	− 0.2991	− 0.2959	− 0.2975	+0.4	26.4426	66.473
T. B. M. 46a	9.4	102.8	+ 0.1731	+ 0.1649	+ 0.1690	+0.4	26.6116	67.027
P. B. M. 23	0.0	102.8	− 0.8261	− 0.8238	− 0.8249	+0.3	25.7866	64.321
P. B. M. 24	10.8	113.6	+ 2.1984	+ 2.2159	+ 2.2071	+0.3	27.9937	71.562
T. B. M. 51a	2.0	115.6	+ 2.3986	+ 2.3952	+ 2.3969	+0.2	30.3905	79.425
P. B. M. 25	0.0	115.6	+ 0.4203	+ 0.4184	+ 0.4193	+0.2	30.8098	80.801
P. B. M. 26	0.0	115.6	+ 0.0460	+ 0.0489	+ 0.0475	+0.2	30.8573	80.957
P. B. M. 27	0.0	115.6	− 0.8926	− 0.8950	− 0.8938	+0.5	29.9638	78.025
P. B. M. 28	0.0	115.6	− 0.7450	− 0.7434	− 0.7442	+0.3	29.2194	75.583
T. B. M. 52	2.8	118.4	+ 0.7691	+ 0.7786	+ 0.7738	+0.2	29.9931	78.121
P. B. M. 29	9.9	128.3	+ 3.5029	+ 3.4984	+ 3.5007	+0.1	33.4937	89.606
T. B. M. 60a	6.4	134.7	+18.9460	+18.9392	+18.9426	−0.8	52.4354	151.750
P. B. M. 30	3.3	138.0	+ 4.1912	+ 4.1908	+ 4.1910	−1.0	56.6262	165.500
T. B. M. 63	2.4	140.4	+ 8.0348	+ 8.0319	+ 8.0334	−1.4	64.6592	191.854
T. B. M. 64a	2.6	143.0	− 4.0721	− 4.0681	− 4.0701	−1.2	60.5893	178.501
T. B. M. 66	9.9	152.9	− 7.4719	− 7.4707	− 7.4713	−0.9	53.1183	153.990
P. B. M. 32	0.0	152.9	− 0.5221	− 0.5214	− 0.5217	−1.0	52.5965	152.279
T. B. M. 67	1.3	154.2	− 2.9576	− 2.9598	− 2.9587	−0.7	49.6381	142.573
T. B. M. 68	1.7	155.9	+ 2.9036	+ 2.8986	+ 2.9011	−0.8	52.5391	152.090
T. B. M. 70	7.0	162.9	+29.7347	+29.7320	+29.7333	−2.2	82.2710	249.635
T. B. M. 71a	2.0	164.9	+18.4824	+18.4837	+18.4831	−3.0	100.7533	310.271
P. B. M. 33	0.0	164.9	+ 1.2746	+ 1.2781	+ 1.2763	−2.9	102.0297	314.460
B. M. Ruston	0.0	164.9	− 1.9282	− 1.9282	− 1.9282	−2.8	100.1016	308.133
T. B. M. 72a	2.6	167.5	−16.5941	−16.5957	−16.5949	−2.1	80.5074	243.849
V. S. & P. B. M	0.0	167.5	− 3.8136	− 3.8136	− 3.8136	−1.9	79.6940	241.181
P. B. M. 34	6.3	173.8	+27.1248	+27.1249	+27.1249	−3.2	106.8176	330.169
T. B. M. 75a	2.9	176.7	− 5.0922	− 5.0924	− 5.0923	−3.0	101.7255	313.461
T. B. M. 77	4.6	181.3	+ 2.0946	+ 2.1051	+ 2.0999	−3.1	103.8253	320.350
P. B. M. 35	0.0	181.3	− 0.0120	− 0.0117	− 0.0118	−3.1	103.8135	320.312
T. B. M. 80	7.1	188.4	+ 9.8214	+ 9.8284	+ 9.8249	−3.6	113.6379	352.543
T. B. M. 81	3.6	192.0	+ 1.9307	+ 1.9302	+ 1.9304	−3.6	115.5683	358.877
P. B. M. 36	0.0	192.0	+ 3.0770	+ 3.0855	+ 3.0812	−4.0	118.6491	368.984
T. B. M. 82	2.9	194.9	− 9.4315	− 9.4334	− 9.4324	−3.4	109.2173	338.040
T. B. M. 83a	3.1	198.0	−22.8284	−22.8219	−22.8251	−2.4	86.3932	263.161
T. B. M. 85a	5.3	203.3	−10.1795	−10.1725	−10.1760	−1.7	76.2179	229.776
T. B. M. 86	3.3	206.6	− 3.2188	− 3.2086	− 3.2137	−1.6	73.0043	219.233
P. B. M. 37	0.0	206.6	+ 6.9205	+ 6.9205	+ 6.9205	−1.2	79.9252	241.941
T. B. M. 88	5.1	211.7	− 5.7547	− 5.7545	− 5.7546	−1.8	74.1700	223.058
P. B. M. 38	0.0	211.7	− 1.4601	− 1.4591	− 1.4596	−1.6	72.7106	218.269
T. B. M. 91a	9.1	220.8	+15.3182	+15.3183	+15.3182	−2.4	88.0280	268.523
P. B. M. 39	2.8	223.6	− 3.8356	− 3.8336	− 3.8346	−2.1	84.1937	255.943
T. B. M. 95	3.4	227.0	−22.7526	−22.7422	−22.7474	−1.2	61.4472	181.316
P. B. M. 40	1.5	228.5	+ 2.3382	+ 2.3344	+ 2.3363	−1.7	63.7830	188.980
P. B. M. 41	2.0	230.5	−14.6479	−14.6572	−14.6525	−0.6	49.1316	140.911
T. B. M. 99	2.9	233.4	+11.0328	+11.0396	+11.0362	−1.2	60.1672	177.117
T. B. M. 101	4.7	238.1	+ 7.7410	+ 7.7305	+ 7.7357	−1.5	67.9026	202.495
P. B. M. 42	0.0	238.1	+ 6.3168	+ 6.3214	+ 6.3191	−2.3	74.2209	223.224
T. B. M. 105	8.0	246.1	− 2.9568	− 2.9419	− 2.9494	−1.7	71.2721	213 550
T. B. M. 106	2.6	248.7	+ 6.8795	+ 6.8837	+ 6.8816	−2.0	78.1534	236.126
P. B. M. 43	0.0	248.7	+ 0.1926	+ 0.1934	+ 0.1930	−2.0	78.3464	236.759
T. B. M. 108	6.1	254.6	−10.5018	−10.5156	−10.5087	−1.5	67.8382	202.284
P. B. M. 44	1.0	255.6	+ 0.4344	+ 0.4386	+ 0.4365	−2.3	68.2739	203.713
T. B. M. 113	10.2	265.8	−11.1953	−11.1988	−11.1970	1.0	57.0782	166.982
T. B. M. 114	2.8	268.6	+ 0.8209	+ 0.8173	+ 0.8191	−1.1	57.8972	169.670
T. B. M. 115	1.2	269.8	− 0.0685	− 0.0632	− 0.0658	−1.1	57.8314	169.454
T. B. M. 116a	1.4	271.2	+ 5.1210	+ 5.1187	+ 5.1198	−1.2	62.9511	186.250
T. B. M. 116a	....	271.2	....	....	....	−1.2	62.9511	186.250
P. B. M. 45	0.0	271.2	− 4.5801	− 4.5811	− 4.5806	−1.4	58.3703	171.221
P. B. M. 46	1.3	272.5	+ 7.4763	+ 7.4727	+ 7.4745	−1.5	65.8447	195.744
Mark for barometer	0.0	272.5	+ 0.9995	+ 1.0008	+ 1.0002	−1.5	66.8449	199.025
Bayou Pierre 2	0.0	272.5	− 5.2503	− 5.2519	− 5.2510	−0.9	61.5945	181.800
Follett's B. M	0.0	272.5	+ 0.8384	+ 0.8397	+ 0.8390	−1.0	62.4332	184.550
T. B. M. 116a	....	271.2	....	....	....	−1.2	62.9511	186.250
T. B. M. 121	11.4	282.6	− 5.6587	− 5.6519	− 5.6553	−0.5	57.2965	167.698
P. B. M. 47	1.6	284.2	− 1.1555	− 1.1610	− 1.1583	−0.5	56.1382	163.901
T. B. M. 123	2.3	286.5	+ 0.7552	+ 0.7611	+ 0.7581	−0.5	56.8963	166.385
T. B. M. 128	9.7	296.2	− 2.1975	− 2.1871	− 2.1923	−0.2	54.7043	159.194
P. B. M. 48	0.0	296.2	− 0.4744	− 0.4737	− 0.4740	−0.2	54.2303	157.639
T. B. M. 129	2.1	298.3	+ 0.1307	+ 0.1307	+ 0.1307	−0.2	54.3610	158.068
T. B. M. 131	5.5	303.8	− 0.5415	− 0.5329	− 0.5372	−0.1	53.8239	156.305

TABLE 1 D.—*Precise levels, etc.—Tabulated results*—Continued.

DELTA TO COUSHATTA, LA.—Continued.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Delta.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
P. B. M. 49	0.0	303.8	-1.2252	-1.2252	-1.2252	0.0	52.5988	152.286
T. B. M. 132	2.4	306.2	+0.6256	+0.6231	+0.6244	0.0	53.2232	154.835
Old B. M	0.0	306.2	+0.2713	+0.2713	+0.2713	0.0	53.4945	155.225
P. B. M. 50	4.2	310.4	-2.1596	-2.1589	-2.1593	+0.1	51.3353	148.141
T. B. M. 136	4.7	315.1	+1.0673	+1.0721	+1.0697	0.0	52.4049	151.650
P. B. M. 51	0.0	315.1	-1.5891	-1.5891	-1.5891	+0.2	50.8160	146.437
T. B. M. 138	3.7	318.8	+1.0625	+1.0620	+1.0623	+0.2	51.8783	149.922
T. B. M. 139	1.6	320.4	+0.5528	+0.5563	+0.5546	0.0	52.4327	151.741
P. B. M. 52	0.0	320.4	-2.3557	-2.3557	-2.3557	+0.2	50.0772	144.013
T. B. M. 141	3.2	323.6	+0.9049	+0.9050	+0.9050	+0.2	50.9822	146.983
P. B. M. 53	0.0	323.6	-1.7101	-1.7087	-1.7094	+0.3	49.2729	141.374
T. B. M. 144	4.2	327.8	+1.2148	+1.2195	+1.2171	+0.3	50.4900	145.368
B. M. a	2.0	329.8	-0.4994	-0.4875	-0.4935	+0.3	49.9965	143.748
P. B. M. 54	0.0	329.8	+0.0090	+0.0090	+0.0090	+0.2	50.0054	143.778
P. B. M. 55	3.7	333.5	-0.6087	-0.6212	-0.6150	+0.4	49.3906	141.761
P. B. M. 56	3.7	340.0	-1.2252	-1.2285	-1.2269	+0.4	48.1637	137.736
P. B. M. 57	17.1	357.1	-1.6909	-1.6587	-1.6748	+0.7	46.4892	132.242

C. and G. S. P. B. M. 215 is used as initial bench. (See Report of Chief of Engineers, 1885, p. 2676.)

From C. and G. S. P. B. M. 215 to P. B. M. 46 was run along the Vicksburg, Shreveport and Pacific Railway by T. C. Thomas, T. G. Rombauer, and E. T. Washburn, February 16 to May 29, 1889.

From P. B. M. 46 to P. B. M. 57 was run along dirt road by T. G. Rombauer and E. J. Thomas, May 29 to July 31, 1889.

Irregular variations of rod correction are due to using two sets of rods, one set too long, the other too short.

COUSHATTA TO GRAND BEND, LA.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Coushatta.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
P. B. M. 57	....	0.0	....	....	....	....	46.4892	132.242
P. B. M. 58	0.0	0.0	+0.4241	+0.4241	+0.4241	0.0	46.9133	133.638
P. B. M. 59	15.7	15.7	-2.1674	-2.2235	-2.1954	+0.2	44.7181	126.431
P. B. M. 60	11.9	27.6	-1.6047	-1.6079	-1.6063	+0.3	43.1119	121.162
P. B. M. 61	9.0	36.6	-0.7346	-0.7179	-0.7273	+0.4	42.3847	118.776
P. B. M. 62	10.1	46.7	+0.0669	+0.0849	+0.0759	+0.2	42.4604	119.024
P. B. M. 63	9.8	56.5	-1.8970	-1.9013	-1.8991	+0.6	40.5617	112.796
P. B. M. 64	8.1	64.6	-1.5502	-1.5633	-1.5567	+0.6	39.0050	107.688
P. B. M. 65	9.2	73.8	-0.8865	-0.9053	-0.8959	+0.9	38.1094	104.749
P. B. M. 66	13.2	87.0	-1.7045	-1.6896	-1.6970	+1.1	36.4126	99.182
P. B. M. 67	4.4	91.4	-2.1109	-2.1204	-2.1157	+1.3	34.2971	92.242
P. B. M. 68	12.0	103.4	-1.7193	-1.7236	-1.7214	+1.5	32.5759	86.595
P. B. M. 69	4.5	107.9	+2.9261	+2.9194	+2.9227	+1.3	35.4984	96.183
P. B. M. 70	10.5	118.4	-0.4919	-0.5021	-0 4970	+1.2	35.0018	94.552
P. B. M. 71	9.4	127.8	-2.6518	-2.6563	-2.6540	+1.6	32.3477	85.846
P. B. M. 72	14.2	142.0	-2.2557	-2.2583	-2.2570	+1.8	30.0909	78.442
P. B. M. 73	14.4	156.4	-1.4527	-1.4450	-1.4488	+2.0	28.6423	73.690
P. B. M. 74	0.0	156.4	-0.8475	-0.8476	-0.8475	+2.1	27.7949	70.910
T. B. M. 86	0.0	156.4	+2.7982	+2.7981	+2.7981	+1.8	30.5927	80.089
B. M. 3	0.0	156.4	-0.1175	....	-0.1175	+1.8	30.4752	79.703
B. M. 4	0.0	156.4	+0.7380	....	+0.7380	+1.6	30.2130	78.843
T. B. M. 86	....	156.4	....	....	....	+1.8	30.5927	80.089
P. B. M. 75	8.1	164.5	-2.3250	-2.3133	-2.3191	+2.0	28.2738	72.481
P. B. M. 76	5.9	170.4	-0.4268	-0.4288	-0.4278	+2.2	27.8462	71.078

P. B. M. 57 is used as initial bench. (See tabulated results, Delta to Coushatta, La., above.)

Levels were run along dirt road by T. G. Rombauer and R. S. Buck, October 18, 1889, to February 14, 1890.

TABLE 1 D.—*Precise levels, etc.—Tabulated results*—Continued.

GRAND BEND TO SMITHLAND, LA.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Grand Bend.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
P. B. M. 76	....	0.0	....	....	....	....	27.8462	71.078
T. B. M. 2	2.9	2.9	+0.5936	+0.5887	+0.5911	0.0	28.4373	73.017
T. B. M. 3	1.3	4.2	−0.7895	−0.8021	−0.7958	0.0	27.6415	70.406
T. B. M. 4	1.6	5.8	−0.0735	−0.0803	−0.0769	0.0	27.5646	70.154
T. B. M. 5	1.6	7.4	−0.0317	−0.0363	−0.0340	0.0	27.5306	70.042
P. B. M. 77	1.8	9.2	−1.1410	−1.1446	−1.1428	+0.1	26.3879	66.293
T. B. M. 7	1.3	10.5	+0.8739	+0.8760	+0.8749	0.0	27.2627	69.164
T. B. M. 8	1.7	12.2	+0.3312	+0.3295	+0.3304	0.0	27.5931	70.248
T. B. M. 9	1.7	13.9	−0.9638	−0.9700	−0.9669	+0.1	26.6263	67.077
T. B. M. 10	1.7	15.6	+0.0861	+0.0862	+0.0862	+0.1	26.7125	67.358
T. B. M. 11	1.4	17.0	+0.0384	+0.0324	+0.0354	+0.1	26.7479	67.474
T. B. M. 13	2.7	19.7	−0.9636	−0.9787	−0.9711	+0.1	25.7768	64.289
T. B. M. 14	1.1	20.8	+0.3987	+0.3942	+0.3965	+0.1	26.1733	65.590
P. B. M. 78	3.9	24.7	−1.4420	−1.4498	−1.4459	+0.2	24.7275	60.846
T. B. M. 19	1.3	26.0	+0.9836	+0.9826	+0.9831	+0.1	25.7105	64.071
T. B. M. 20	0.5	26.5	−0.1207	−0.1234	−0.1221	+0.2	25.5885	63.671
T. B. M. 23	3.0	29.5	−0.0382	−0.0454	−0.0418	+0.2	25.5467	63.534
T. B. M. 24	0.8	30.3	−0.3286	−0.3323	−0.3305	+0.2	25.2162	62.449
T. B. M. 26	1.6	31.9	+0.2179	+0.2131	+0.2155	+0.2	25.4317	63.156
P. B. M. 79	0.0	31.9	−0.5070	−0.5076	−0.5073	+0.2	24.9244	61.492
T. B. M. 28	1.6	33.5	+0.7817	+0.7774	+0.7796	+0.1	25.7039	64.049
T. B. M. 31	2.6	36.1	−0.1274	−0.1264	−0.1269	+0.2	25.5771	63.634
T. B. M. 32	1.0	37.1	−0.0399	−0.0437	−0.0418	+0.2	25.5353	63.496
T. B. M. 35	2.5	39.6	−0.0856	−0.0888	−0.0872	+0.2	25.4481	63.210
T. B. M. 36	0.2	39.8	+0.0834	+0.0830	+0.0832	+0.2	25.5313	63.483
P. B. M. 80	4.8	44.6	+0.8741	+0.8757	+0.8749	+0.1	26.4061	66.353
T. B. M. 42	2.8	47.4	−1.6941	−1.6980	−1.6960	+0.2	24.7102	60.789
T. B. M. 43	1.3	48.7	+0.0295	+0.0297	+0.0296	+0.2	24.7398	60.886
T. B. M. 48	4.6	53.3	−0.5606	−0.5715	−0.5661	+0.3	24.1738	59.030
T. B. M. 49	0.6	53.9	−0.5808	−0.5826	−0.5817	+0.3	23.5921	57.121
P. B. M. 81	0.0	53.9	+1.3445	+1.3447	+1.3446	+0.2	24.9366	61.532
P. B. M. 82	0.0	53.9	+0.0811	+0.0819	+0.0815	+0.2	25.0181	61.800
T. B. M. 51	2.6	56.5	+4.6473	+4.6483	+4.6478	−0.1	29.6656	77.047
T. B. M. 51a	0.0	56.5	−6.1131	−6.1131	−6.1131	+0.3	23.5529	56.992
T. B. M. 52	1.1	57.6	+6.3177	+6.3131	+6.3154	−0.1	29.8679	77.711
T. B. M. 53	1.4	59.0	+0.4931	+0.4910	+0.4920	−0.2	30.3598	79.324
T. B. M. 55	2.1	61.1	+0.6828	+0.6872	+0.6850	−0.2	31.0448	81.572
P. B. M. 83	0.8	61.9	+1.8104	+1.8128	+1.8116	−0.4	32.8562	87.515
T. B. M. 58	3.1	65.0	−4.5636	−4.5651	−4.5644	0.0	28.2922	72.541
T. B. M. 62	6.4	71.4	+0.7753	+0.7729	+0.7741	−0.1	29.0662	75.080
P. B. M. 84	0.0	71.4	+0.4095	+0.4084	+0.4090	−0.1	29.4752	76.422
P. B. M. 85	0.3	71.7	+0.9937	+0.9960	+0.9948	−0.2	30.4699	79.686
T. B. M. 64	2.0	73.7	+0.5678	+0.5677	+0.5677	−0.2	31.0376	81.548
T. B. M. 64a	1.4	75.1	−9.4151	−9.4097	−9.4124	+0.4	21.6258	50.670
T. B. M. 66	2.3	77.4	+1.9064	+1.9095	+1.9079	+0.3	23.5336	56.929
T. B. M. 67	1.2	78.6	−0.9045	−0.9063	−0.9054	+0.4	22.6283	53.959
T. B. M. 68	1.3	79.9	+0.7900	+0.7945	+0.7922	+0.3	23.4204	56.558
T. B. M. 69	1.1	81.0	+0.0895	+0.0902	+0.0898	+0.3	23.5102	56.852
P. B. M. 86	0.0	81.0	+1.3422	+1.3423	+1.3422	+0.2	24.8523	61.255
T. B. M. 70	1.0	82.0	−1.3334	−1.3319	−1.3326	+0.3	23.5198	56.884
T. B. M. 72	3.3	85.3	−3.5976	−3.5983	−3.5980	+0.5	19.9220	45.080
T. B. M. 73	1.2	86.5	+1.3603	+1.3600	+1.3602	+0.4	21.2821	49.542
P. B. M. 87	1.0	87.5	+1.8809	+1.8702	+1.8755	+0.3	23.1575	55.695
T. B. M. 74	0.1	87.6	−1.2791	−1.2791	−1.2791	+0.4	21.8785	51.499
T. B. M. 75	1.2	88.8	−0.4844	−0.4858	−0.4851	+0.4	21.3931	49.908
T. B. M. 80	6.9	95.7	−0.2606	−0.2623	−0.2615	+0.5	21.1320	49.050
T. B. M. 81	1.5	97.2	−0.2714	−0.2703	−0.2709	+0.5	20.8611	48.161
T. B. M. 82	1.7	98.9	−0.2180	−0.2121	−0.2151	+0.5	20.6460	47.455
T. B. M. 83	1.2	100.1	+0.0257	+0.0259	+0.0258	+0.5	20.6718	47.540
P. B. M. 88	0.0	100.1	+0.9069	+0.9067	+0.9068	+0.4	21.5785	50.515
T. B. M. 84	1.4	101.5	−1.1042	−1.0998	−1.1020	+0.5	20.4766	46.900
T. B. M. 85	1.0	102.5	−0.1730	−0.1692	−0.1711	+0.5	20.3055	46.338
P. B. M. 89	0.0	102.5	−1.3336	−1.3346	−1.3341	+0.6	18.9715	41.962
T. B. M. 86	0.7	103.2	+1.9809	+1.9799	+1.9804	+0.5	20.9518	48.459
Wilson's B. M. 4	0.0	103.2	−0.3523	−0.3596	−0.3560	+0.5	20.5958	47.291
T. B. M. 87	1.8	105.0	+0.1962	+0.2033	+0.1998	+0.5	20.7956	47.946
T. B. M. 89	2.5	107.5	+0.2597	+0.2584	+0.2590	+0.5	21.0546	48.796
T. B. M. 91	2.0	109.5	+0.2035	+0.2057	+0.2046	+0.4	21.2591	49.467
T. B. M. 92	1.0	110.5	+0.1952	+0.1943	+0.1948	+0.4	21.4539	50.106
P. B. M. 90	0.6	111.1	−2.2505	−2.2574	−2.2540	+0.6	19.2001	42.712
P. B. M. 91	0.0	111.1	+0.5651	+0.5657	+0.5654	+0.5	19.7654	44.566
T. B. M. 94	1.1	112.2	+1.6270	+1.6267	+1.6268	+0.4	21.3921	49.903
P. B. M. 92	0.0	112.2	−1.5456	−1.5456	−1.5456	+0.5	19.8466	44.833

TABLE 1 D.—*Precise levels, etc.—Tabulated results*—Continued.

GRAND BEND TO SMITHLAND, LA.—Continued.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Grand Bend.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
P. B. M. 93	0.5	112.7	+1.5054	+1.5037	+1.5045	+0.4	21.3510	49.768
P. B. M. 94	0.5	113.2	+0.2020	+0.1989	+0.2004	+0.4	21.5514	50.426
T. B. M. 95	2.3	115.5	0.2006	−0.1938	−0.1972	+0.4	21.3542	49.779
T. B. M. 96	0.9	116.4	−0.2080	−0.2070	−0.2075	+0.5	21.1468	49.098
T. B. M. 97	2.1	118.5	+0.3899	+0.3862	+0.3880	+0.4	21.5347	50.371
T. B. M. 98	1.6	120.1	−0.1110	−0.1150	−0.1130	+0.4	21.4217	50.000
M. R. C. B. M. $^{1}_{3}{}^{9}$	1.3	121.4	+0.7073	+0.7055	+0.7064	+0.4	22.1281	52.318
T. B. M. 99	1.2	122.6	−1.9767	−1.9729	−1.9748	+0.5	20.1534	45.839
T. B. M. 101	2.1	124.7	+0.0624	+0.0644	+0.0634	+0.5	20.2168	46.047
M. R. C. B. M. $^{1}_{1}{}^{0}$	1.5	126.2	+0.1578	+0.1541	+0.1559	+0.5	20.3727	46.559
C. and G. S. B. M. XLV	0.0	126.2	+0.6299	+0.6343	+0.6321	+0.5	21.0048	48.633

P. B. M. 76 is used as initial bench. (See tabulated results, Coushatta to Grand Bend, La., p. 1458.)
Levels were run along dirt road by Alex. E. Kastl, October 8, 1891, to January 21, 1892.
Elevation of C. and G. S. P. B. M. XLV, 14.8234 meters, Gulf level. (See Report of Chief of Engineers, 1900, p. 4721.)

DELTA, LA., TO GREENVILLE, MISS., VIA YAZOO CITY AND GREENWOOD, MISS.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Delta.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
/△ S. W. Base		0.0					32.8374	87.453
T. B. M. 4	1.6	1.6	+ 1.0172	+ 1.0137	+ 1.0154	−0.1	33.8527	90.784
△ N. E. Base	1.5	3.1	+ 0.2203	+ 0.2175	+ 0.2189	−0.2	34.0715	91.502
M. R. C. B. M. $^{1}{}^{9}_{1}{}^{7}$	3.1	6.2	− 1.0231	− 1.0462	− 1.0346	0.0	33.0371	88.108
C. and G. S. B. M. B	1.1	5.5	+ 3.1497	+ 3.1502	+ 3.1499	−0.5	36.1865	98.441
C. and G. S. B. M. B		5.5				−0.5	36.1865	98.441
M. R. C. B. M. $^{1}{}^{9}_{1}{}^{7}$	1.4	6.9	− 3.1224	− 3.1240	− 3.1232	−0.1	33.0637	88.196
P. B. M. A. and V	1.8	8.7	+33.2721	+33.2738	+33.2730	−4.5	66.3323	197.344
C. and G. S. B. M. C	0.8	9.5	+ 2.5871	+ 2.5901	+ 2.5886	−4.9	68.9205	205.835
P. B. M. D	0.1	9.6	− 2.4851	− 2.4860	− 2.4856	− 4.5	66.4353	197.681
P. B. M. E	1.7	11.3	+15.6993	+15.6944	+15.6968	−6.7	82.1299	249.173
P. B. M. F	1.1	12.4	+ 4.1599	+ 4.1610	+ 4.1604	−7.2	86.2898	262.820
P. B. M. Tappan	0.5	12.9	+20.2175	+20.2254	+20.2214	− 9.9	106.5085	329.154
B. M. East Gate	1.2	14.1	−34.8235	−34.8208	−34.8222	−5.3	71.6909	214.924
P. B. M. 2	0.7	14.8	−36.0487	−36.0477	−36.0482	−0.4	35.6476	96.673
C. and G. S. B. M. B		5.5				−0.5	36.1865	98.441
P. B. M. 1	6.5	12.0	+ 1.3983	+ 1.3928	+ 1.3955	−0.6	37.5819	103.019
P. B. M. 2	1.1	13.1	− 1.9308	− 1.9294	− 1.9301	−0.3	35.6521	96.688
P. B. M. 1		12.0				−0.6	37.5819	103.019
P. B. M. 2	1.0	13.0	− 1.9296	− 1.9270	− 1.9283	−0.3	35.6539	96.694
P. B. M. 1		12.0				−0.6	37.5819	103.019
P. B. M. 2	0.9	12.9	− 1.9186	− 1.9263	− 1.9224	−0.3	35.6598	96.713
P. B. M. 1		12.0				−0.6	37.5819	103.019
P. B. M. 6	9.3	21.3	− 2.9774	− 2.9667	− 2.9720	−0.2	34.6103	93.270
P. B. M. 2		13.0				−0.3	35.6539	96.694
T. B. M. 1	1.7	14.7	− 4.9640	− 4.9656	− 4.9648	+0.8	30.6902	80.409
T. B. M. 2	1.3	16.0	+ 0.9570	+ 0.9515	+ 0.9542	+0.6	31.6142	83.538
T. B. M. 3	1.1	17.1	− 0.3920	− 0.3952	− 0.3936	+0.7	31.2507	82.247
T. B. M. 4	0.9	18.0	+ 0.3810	+ 0.3811	+ 0.3810	+0.6	31.6316	83.497
T. B. M. 5	1.0	19.0	− 0.1142	− 0.1160	0.1151	+0.6	31.5165	83.119
T. B. M. 6	0.9	19.9	+2.6540	+2.6497	+2.6518	0.0	34.1677	91.817
T. B. M. 7	1.1	21.0	+0.4780	+0.4777	+0.4778	−0.1	34.6454	93.384
T. B. M. 8	1.0	22.0	0.4672	0.4670	−0.4671	0.0	34.1784	91.853
T. B. M. 9	0.9	22.9	−0.0840	0.0828	−0.0834	+0.1	34.0951	91.579
T. B. M. 10	1.1	24.0	+0.1307	+0.1293	+0.1300	0.0	34.2250	92.005
T. B. M. 11	0.9	24.9	+1.1318	+1.1317	+1.1318	−0.2	35.3566	95.718

TABLE 1 D.—*Precise levels, etc.—Tabulated results*—Continued.

DELTA, LA., TO GREENVILLE, MISS., VIA YAZOO CITY AND GREENWOOD, MISS.—Continued.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Delta.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
T. B. M. 12	1.1	26.0	−0.4500	−0.4532	−0.4516	−0.1	34.9051	94.237
P. B. M. 6	1.3	27.3	−0.2917	−0.2961	−0.2939	−0.1	34.6112	93.273
P. B. M. 2	....	13.0	....	....	....	−0.3	35.6539	96.694
P. B. M. 3	8.6	21.6	+4.9956	+4.9866	+4.9911	−0.9	40.6444	113.066
P. B. M. 4	5.3	26.9	−5.7217	−5.7155	−5.7186	−0.2	34.9265	94.307
P. B. M. 5	0.0	26.9	+3.4237	+3.4237	+3.4237	−0.7	38.3497	105.538
T. B. M. 1	0.7	27.6	−3.3354	−3.3353	−3.3354	0.0	35.0150	94.597
T. B. M. 4	3.6	31.2	−0.7020	−0.7080	−0.7050	+0.1	34.3101	92.285
T. B. M. 5	1.5	32.7	+0.4642	+0.4586	+0.4614	0.0	34.7714	93.798
T. B. M. 8	5.7	38.4	+7.0632	+7.0417	+7.0524	−1.4	41.8224	116.931
T. B. M. 9	1.7	40.1	−2.3817	−2.3849	−2.3833	−0.9	39.4396	109.114
T. B. M. 10	1.7	41.8	−1.2526	−1.2585	−1.2556	−0.7	38.1842	104.995
P. B. M. 7	0.0	41.8	−0.9213	−0.9165	−0.9189	−0.5	37.2655	101.981
T. B. M. 12	3.1	44.9	−1.2042	−1.2010	−1.2026	−0.3	36.0631	98.036
T. B. M. 16	5.5	50.4	−5.5526	−5.5514	−5.5520	+0.8	30.5122	79.825
T. B. M. 21	7.1	57.5	+4.0481	+4.0464	+4.0473	0.0	34.5587	93.100
T. B. M. 24a	4.3	61.8	+0.0313	+0.0268	+0.0290	0.0	34.5877	93.195
P. B. M. 8	0.0	61.8	+0.4398	+0.4391	+0.4394	−0.1	35.0270	94.637
P. B. M. 9	0.0	61.8	−1.9360	−1.9478	−1.9419	+0.3	33.0855	88.267
T. B. M. 25	1.5	63.3	+2.0619	+2.0735	+2.0677	−0.1	35.1528	95.049
T. B. M. 27	3.2	66.5	+1.0499	+1.0457	+1.0478	−0.3	36.2004	98.487
T. B. M. 28	1.5	68.0	−0.4964	−0.4974	−0.4969	−0.2	35.7036	96.857
T. B. M. 58	1.4	69.4	−0.3713	−0.3701	−0.3707	−0.1	35.3330	95.641
T. B. M. 55	4.7	74.1	+1.8808	+1.8794	+1.8801	−0.5	37.2127	101.807
P. B. M. 10	1.4	75.5	−1.3486	−1.3571	−1.3528	−0.2	35.8602	97.370
T. B. M. 52	2.3	77.8	+0.3101	+0.3029	+0.3065	−0.3	36.1666	98.375
T. B. M. 51	1.5	79.3	+0.1668	+0.1679	+0.1674	−0.3	36.3340	98.925
T. B. M. 47	6.4	85.7	+1.0339	+1.0202	+1.0271	−0.5	37.3609	102.294
T. B. M. 45	3.1	88.8	+0.0213	+0.0188	+0.0201	−0.5	37.3810	102.360
P. B. M. 11	0.0	88.8	−0.8656	−0.8649	−0.8652	−0.3	36.5160	99.522
T. B. M. 43	2.5	91.3	+0.3309	+0.3275	+0.3292	−0.4	36.8451	100.602
T. B. M. 42	1.8	93.1	+0.1732	+0.1750	+0.1741	−0.4	37.0192	101.173
T. B. M. 41	1.6	94.7	−0.9010	−0.9056	−0.9033	−0.3	36.1160	98.209
T. B. M. 40	1.4	96.1	+1.1268	+1.1291	+1.1280	−0.5	37.2438	101.909
T. B. M. 39	2.1	98.2	−0.4642	−0.4593	−0.4618	−0.4	36.7821	100.395
T. B. M. 38	1.3	99.5	−0.6687	−0.6728	−0.6708	−0.3	36.1114	98.195
T. B. M. 37	1.5	101.0	+0.8139	+0.8081	+0.8110	−0.4	36.9223	100.855
T. B. M. 35	3.0	104.0	+0.2285	+0.2206	+0.2246	−0.5	37.1468	101.592
T. B. M. 34	1.3	105.3	−0.4129	−0.4147	−0.4138	−0.4	36.7331	100.234
T. B. M. 33	1.1	106.4	+0.3430	+0.3440	+0.3435	−0.5	37.0765	101.361
T. B. M. 32	1.7	108.1	+1.3841	+1.3835	+1.3838	−0.7	38.4601	105.900
T. B. M. 31	1.5	109.6	−4.0576	−4.0639	−4.0607	+0.1	34.4002	92.580
P. B. M. 12	0.9	110.5	+7.5889	+7.5904	+7.5896	−1.4	41.9883	117.475
P. B. M. 13	0.4	110.9	−4.5431	−4.5437	−4.5434	−0.5	37.4458	102.572
T. B. M. 208	2.6	112.5	+1.8588	+1.8584	+1.8586	−0.8	39.3041	108.669
P. B. M. 29	23.8	136.3	−0.2486	−0.2561	−0.2523	−0.8	39.0518	107.841
T. B. M. 188	7.9	144.2	+1.6303	+1.6085	+1.6194	−1.1	40.6709	113.153
P. B. M. 28	11.8	156.0	+1.5448	+1.5128	+1.5288	−1.4	42.1994	118.168
P. B. M. 27	0.0	156.0	−1.1628	−1.1618	−1.1623	−1.2	41.0373	114.355
T. B. M. 171	14.1	170.1	+1.9439	+1.9418	+1.9428	−1.6	42.9797	120.728
P. B. M. 26	11.2	181.3	+0.5023	+0.4948	+0.4986	−1.6	43.4783	122.364
T. B. M. 164	0.0	181.3	+0.9196	+0.9189	+0.9192	−1.8	44.3973	125.379
P. B. M. 25	13.3	194.6	−0.0476	−0.0435	−0.0455	−1.8	44.3518	125.229
T. B. M. 156	0.0	194.6	+0.7290	+0.7276	+0.7283	−2.0	45.0799	127.618
P. B. M. 24	0.9	195.5	+0.4689	+0.4680	+0.4684	−2.1	45.5482	129.154
T. B. M. 155a	0.0	195.5	+1.1326	+1.1329	+1.1328	−2.3	46.6808	132.870
T. B. M. 155	0.0	195.5	−1.3539	−1.3563	−1.3551	−2.0	45.3260	128.426
P. B. M. 23	6.4	201.9	+1.8352	+1.8375	+1.8363	−2.4	47.1619	134.449
P. B. M. 22	0.6	202.5	−1.8577	−1.8593	−1.8585	−2.0	45.3038	128.353
P. B. M. 21	6.5	209.0	−1.0125	−1.0102	−1.0113	−1.8	44.2927	125.036
T. B. M. 135	19.4	228.4	−2.5638	−2.5247	−2.5442	−1.3	41.7490	116.690
T. B. M. 131	6.4	234.8	+0.7498	+0.7703	+0.7600	−1.5	42.5088	119.183
P. B. M. 20	1.4	236.2	−0.5965	−0.5962	−0.5963	−1.4	41.9126	117.227
P. B. M. 19	0.0	236.2	−0.7290	−0.7264	−0.7277	−1.2	41.1851	114.840
P. B. M. 18	0.0	236.2	+3.5459	+3.5453	+3.5456	−1.9	44.7300	126.470
T. B. M. 129	2.1	238.3	−2.7536	−2.7533	−2.7534	−1.4	41.9771	117.438
P. B. M. 17	4.8	243.1	+0.0230	+0.0189	+0.0210	−1.4	41.9981	117.508
P. B. M. 16	6.8	249.9	+1.2087	+1.2100	+1.2093	−1.6	43.2072	121.474
T. B. M. 121	1.3	251.2	−0.2762	−0.2752	−0.2757	−1.6	42.9315	120.570
P. B. M. 15	11.0	262.2	−1.7401	−1.7214	−1.7308	−1.2	41.2011	114.890
P. B. M. 14	6.0	268.2	+2.2910	+2.2891	+2.2900	−1.7	43.4906	122.404
T. B. M. 108	2.4	270.6	−0.7870	−0.7894	−0.7882	−1.5	42.7026	119.818
T. B. M. 107	1.7	272.3	−0.2131	−0.2114	−0.2122	−1.5	42.4904	119.123
T. B. M. 105	2.8	275.1	+0.0771	+0.0816	+0.0794	−1.5	42.5698	119.384

TABLE 1 D.—*Precise levels, etc.—Tabulated results*—Continued.

DELTA, LA., TO GREENVILLE, MISS., VIA YAZOO CITY AND GREENWOOD, MISS.—Continued.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Delta.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
T. B. M. 104	1.6	276.7	+0.7829	+0.7823	+0.7826	−1.6	43.3523	121.950
T. B. M. 103	1.4	278.1	+0.4477	+0.4504	+0.4490	−1.7	43.8012	123.423
T. B. M. 101	2.9	281.0	+1.0492	+1.0572	+1.0532	−1.9	44.8542	126.878
P. B. M. Greenville No. 1 (C. and G. S.)	1.3	282.3	+1.3808	+1.3833	+1.3820	−2.2	46.2359	131.409

△ S. W. base is used as initial bench. (See tabulated results, Delta to Coushatta, La., p. 1456.)

From △ S. W. base to P. B. M. 1 was run by G. C. Haydon, Walter H. Polk, and William R. Neely, at intervals during January and February, 1897.

P. B. M. 1 to P. B. M. 5 was run along Yazoo and Mississippi Valley Railway track by R. S. Buck, October 22 to November 21, 1890.

P. B. M. 2 to P. B. M. 6 was run along dirt road by Joseph Wright, February 27 to March 10, 1900.

P. B. M. 5 to Greenville No. 1 was run along dirt road to Yazoo City, thence along Illinois Central Railway track to Greenwood, thence along the Southern Railway to Greenville, by Walter H. Polk, November 12, 1892, to June 2, 1893.

Elevation of P. B. M. Greenville No. 1, by line from Parkeville, La., to Greenville, Miss., via Arkansas City, Ark., 46.1313 meters, Cairo datum.

Elevation of P. B. M. Greenville No. 1, by United States Coast and Geodetic Survey, 131.111 feet, Gulf level. (See their report for 1898–99, Appendix 8, page 483.)

DELHI TO TENSAS RIVER, LA., VIA WARSAW LANDING, BAYOU MAÇON, LA.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Delhi.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
P. B. M. 13	....	0.00	....	....	....	....	34.9267	94.307
B. M. Delhi	0.09	0.09	0.2868	−0.2871	−0.2870	+0.1	34.6398	93.366
T. B. M. 1	0.25	0.31	+0.9207	+0.9228	+0.9218	−0.1	35.5614	96.390
T. B. M. 2	1.02	1.36	0.1740	0.1731	−0.1735	−0.1	35.3879	95.821
T. B. M. 3	1.41	2.77	−0.7670	0.7707	−0.7689	+0.1	34.6192	93.299
T. B. M. 4	1.39	4.16	−0.7029	−0.7075	0.7052	+0.2	33.9141	90.985
T. B. M. 5	1.35	5.51	−0.7532	−0.7527	−0.7529	+0.4	33.1614	88.516
T. B. M. 6	1.49	7.00	−0.1952	0.1996	−0.1974	+0.4	32.9640	87.864
T B. M. 7	1.47	8.47	−1.8602	1.8626	1.8614	+0.8	31.1030	81.763
T. B. M. 8	1.45	9.92	+0.6995	+0.7024	+0.7009	+0.7	31.8038	84.062
T. B. M. 9	1.61	11.53	+0.0400	+0.0371	+0.0385	+0.7	31.8423	84.188
T. B. M. 10	0.92	12.45	+0.6513	+0.6494	+0.6504	+0.5	32.4925	86.321
T. B. M. 10	....	12.45	....	....	....	+0.5	32.4925	86.321
P. B. M. Griffin	0.96	13.41	+0.2179	+0.2217	+0.2198	+0.5	32.7123	87.042
B. M. 26 (Maçon, '98)	0.73	14.14	−4.0807	−4.0807	−4.0807	+1.4	28.6325	73.656
T. B. M. 10	....	12.45	....	....	....	+0.5	32.4925	86.321
T. B. M. 11	1.08	13.53	+0.7050	+0.7095	+0.7072	+0.4	33.1996	88.641
T. B. M. 12	1.36	14.89	−0.4526	−0.4540	−0.4533	+0.5	32.7464	87.154
T. B. M. 13	1.33	16.22	+1.0846	+1.0849	+1.0848	+0.2	33.8309	90.713
T. B. M. 15	2.18	18.40	−0.6790	−0.6737	−0.6764	+0.4	33.1547	88.492
T. B. M. 16	0.48	18.88	+1.5762	+1.5734	+1.5748	0.0	34.7291	93.659
T. B. M. 17	1.03	19.91	−0.2694	−0.2703	0.2698	+0.1	34.4594	92.774
B. M. 30 (Maçon, '98)	0.72	20.63	2.4899	−2.4916	−2.4907	+0.7	31.9693	84.606
B. M. 30 (Maçon, '98)	....	20.63	....	....	....	+0.7	31.9693	84.605
P. B. M. Newcomer	1.59	22.22	+2.2164	+2.2185	+2.2174	+0.2	34.1862	91.878
B. M. 30 (Maçon, '98)	....	20.63	....	....	....	+0.7	31.9693	84.605
T. B. M. 19	1.00	21.63	3.1303	−3.1294	−3.1300	+1.4	28.8400	74.338
T. B. M. 20	1.27	22.90	−0.1351	−0.1357	−0.1354	+1.4	28.7046	73.894
T. B. M. 21	1.08	23.98	+0.7543	+0.7505	+0.7524	+1.2	29.4568	76.362
T. B. M. 21	....	23.98	....	....	....	+1.2	29.4568	76.362
B. M. 29 (Maçon, '98)	0.35	24.33	0.1455	−0.1432	−0.1443	+1.2	29.3137	75.892
T. B. M. 21	....	23.98	....	....	....	+1.2	29.4568	76.362
T. B. M. 26	5.90	29.88	−3.6151	−3.6241	−3.6197	+2.0	25.8379	64.489
T. B. M. 28	2.27	32.15	+2.0109	+2.0123	+2.0116	+1.6	27.8491	71.088
B. M. 25 (Tensas, '98)	0.58	32.73	+0.9336	+0.9321	+0.9328	+1.4	28.7817	74.147
B. M. 24 (Tensas, '98)	1.34	34.07	+0.3711	+0.3777	+0.3759	+1.3	29.1575	75.380
P. B. M. Gray	−1.30	32.77	−0.0334	−0.0374	−0.0354	+1.3	29.1221	75.264

P. B. M. 13 is used as initial bench. (See tabulated results, Delta to Coushatta, La., p. 1456.)
Levels were run along dirt road by T. C. Thomas, September 16 to October 2, 1899.

TABLE 1 D.—*Precise levels, etc.—Tabulated results*—Continued.

RAYVILLE TO CONCORDIA, LA.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Rayville.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
P. B. M. 16	....	0.00	....	....	....	....	30.6624	80.317
P. B. M. 17	0.00	0.00	+2.3297	+2.3297	+2.3297	−0.3	32.9918	87.960
T. B. M. 1	0.02	0.02	−1.1857	−1.1864	−1.1860	−0.2	31.8059	84.069
T. B. M. 2	0.83	0.85	−1.2128	−1.2115	−1.2122	0.0	30.5939	80.093
T. B. M. 5	7.23	8.08	−1.6608	−1.6705	−1.6657	+0.2	28.9284	74.628
P. B. M. Burke	0.00	8.08	+0.3082	−0.3082	−0.3082	+0.1	29.2365	75.639
T. B. M. 6	1.73	9.81	−0.6057	−0.6049	−0.6053	+0.3	28.6314	73.654
T. B. M. 8	3.16	12.97	+0.1111	+0.1092	+0.1102	+0.3	28.7416	74.016
P. B. M. Archibald	1.82	14.79	+0.8690	+0.8715	+0.8702	+0.1	29.6116	76.870
T. B. M. 9	1.67	16.46	+0.2244	+0.2215	+0.2230	+0.1	29.8346	77.601
P. B. M. Mangham	3.01	19.47	−0.9046	−0.9075	−0.9060	+0.2	28.9287	74.629
T. B. M. 11	0.98	20.45	−0.7348	−0.7333	−0.7341	+0.3	28.1947	72.221
P. B. M. Big Creek	1.45	21.90	+0.6635	+0.6597	+0.6616	+0.2	28.8562	74.391
T. B. M. 12	1.98	23.88	−0.0330	−0.0354	−0.0342	+0.2	28.8220	74.279
P. B. M. Baskin	2.01	25.89	−0.1628	−0.1588	−0.1608	+0.3	28.6613	73.752
P. B. M. Steele	7.88	33.77	−0.4619	−0.4612	−0.4616	+0.3	28.1997	72.238
T. B. M. 17	1.29	35.06	−0.4352	−0.4338	−0.4345	+0.4	27.7653	70.812
P. B. M. Winnsboro	1.83	36.89	+0.4044	+0.4066	+0.4055	+0.3	28.1707	72.142
T. B. M. 19	3.09	39.98	+0.6352	+0.6423	+0.6387	+0.2	28.8093	74.238
T. B. M. 20	1.46	41.44	−2.0123	−2.0065	−2.0094	+0.5	26.8002	67.646
P. B. M. Eden	2.03	43.47	+1.2241	+1.2271	+1.2256	+0.4	28.0257	71.667
P. B. M. Gilbert	8.50	51.97	+1.8520	+1.8554	+1.8537	+0.1	29.8791	77.748
T. B. M. 27	4.82	56.79	−0.2979	−0.3087	−0.3033	+0.1	29.5758	76.752
P. B. M. Wisner	3.13	59.92	−0.6148	−0.6091	−0.6119	+0.2	28.9640	74.745
T. B. M. 29	1.62	61.54	−0.5132	−0.5092	−0.5112	+0.3	28.4529	73.068
P. B. M. Elam	1.15	62.69	−0.2617	−0.2612	−0.2615	+0.3	28.1914	72.210
T. B. M. 30	1.56	64.25	−4.2067	−4.2113	−4.2090	+0.9	23.9830	58.404
P. B. M. Peck	1.70	65.95	+4.9967	+4.9961	+4.9964	+0.2	28.9787	74.793
T. B. M. 31	1.84	67.79	−0.4788	−0.4846	−0.4817	+0.3	28.4971	73.213
P. B. M. Newman	2.06	69.85	−0.5532	−0.5507	−0.5519	+0.4	27.9453	71.403
P. B. M. Chisum	1.99	71.84	+0.1019	+0.1031	+0.1025	+0.4	28.0477	71.739
P. B. M. Florence	2.62	74.46	+0.1937	+0.1929	+0.1933	+0.3	28.2410	72.373
T. B. M. 35	4.06	78.52	−5.7049	−5.7018	−5.7034	+1.1	22.5384	53.664
P. B. M. Copeland	3.56	82.08	+3.1678	+3.1692	+3.1685	+0.7	25.7065	64.058
P. B. M. Copeland	....	82.08	....	....	....	+0.7	25.7065	64.058
T. B. M. B	2.17	84.25	+0.3543	+0.3570	+0.3557	+0.6	26.0621	65.225
T. B. M. C	1.42	85.67	−1.3090	−1.3115	−1.3102	+0.8	24.7521	60.927
P. B. M. Kirk	2.02	87.69	+1.2310	+1.2262	+1.2286	+0.6	25.9805	64.957
P. B. M. Copeland	....	82.08	....	....	....	+0.7	25.7065	64.058
P. R. P. Tensas	4.29	86.37	+0.1336	+0.1262	+0.1299	+0.6	25.8363	64.484
P. B. M. Lee Bayou	3.24	89.61	−0.3305	−0.3353	−0.3329	+0.7	25.5035	63.392
P. R. P. Clayton	5.30	94.91	−0.6209	−0.6316	−0.6263	+0.8	24.8773	61.337
P. B. M. Cypress	5.48	100.39	0.9383	−0.9481	−0.9432	+0.9	23.9342	58.243
P. B. M. Helena	5.59	105.98	+0.6611	+0.6518	+0.6564	+0.8	24.5905	60.396
P. B. M. Concordia	1.42	107.40	−0.0200	−0.0212	−0.0206	+0.8	24.5699	60.329
T. B. M. A	1.52	108.92	+0.9893	+0.9887	+0.9890	+0.7	25.5588	63.573
B. M. 384	0.00	108.92	+1.3990	+1.3993	+1.3992	+0.5	26.9578	68.163
T. B. M. 9	1.42	110.34	−1.2097	−1.2128	−1.2113	+0.7	25.7460	64.188

P. B. M. 16 is used as initial bench. (See tabulated results Delta to Coushatta, La., p. 1456.)

T. B. M. 9 is used as closing bench. Elevation, 25.7885 meters by line from Jonesville to Vidalia, La., via Natchez, Miss.

Levels were run along track of the New Orleans and Northwestern Railway by Walter H. Polk, December 11, 1897, to February 3, 1898.

ARCHIBALD TO BELLEVUE AND THREE RIVERS, LA.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Archibald.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
P. B. M. Archibald	....	0.00	....	....	....	....	29.6116	76.870
T. B. M. 53	1.02	1.02	−1.8370	−1.8367	−1.8368	+0.4	27.7752	70.845
T. B. M. 54	1.19	2.21	+0.0553	+0.0533	+0.0543	+0.4	27.8295	71.023
T. B. M. 55	1.01	3.22	+0.6230	+0.6269	+0.6250	+0.3	28.4544	73.073

TABLE 1 D.—*Precise levels, etc.—Tabulated results*—Continued.

ARCHIBALD TO BELLEVUE AND THREE RIVERS, LA.—Continued.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Archibald.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
T. B. M. 56	0.83	4.05	+0.2374	+0.2394	+0.2384	+0.2	28.6927	73.855
T. B. M. 57	1.33	5.38	−0.2051	−0.1999	−0.2026	+0.3	28.4902	73.191
T. B. M. 58	1.04	6.42	−1.2705	−1.2686	−1.2696	+0.5	27.2208	69.028
T. B. M. 59	1.20	7.62	+1.0101	+1.0136	+1.0118	+0.3	28.2324	72.345
T. B. M. Alto	1.20	8.82	+0.6766	+0.6779	+0.6772	+0.2	28.9095	74.566
P. R. P. Alto	0.16	8.98	−0.1780	−0.1777	−0.1778	+0.2	28.7317	73.983
T. B. M. 60	1.19	10.17	−0.7560	−0.7523	−0.7542	+0.4	27.9777	71.509
T. B. M. 61	0.98	11.15	+1.1772	+1.1778	+1.1775	+0.1	29.1549	75.370
T. B. M. 62	1.21	12.36	−0.6789	−0.6762	−0.6776	+0.3	28.4775	73.149
P. B. M. Harland	1.79	14.15	+0.2218	+0.2226	+0.2222	+0.2	28.6996	73.878
T. B. M. 63	0.87	15.02	−0.7118	−0.7090	−0.7101	+0.4	27.9894	71.548
T. B. M. 64	1.05	16.07	+0.2429	+0.2413	+0.2421	+0.3	28.2314	72.342
T. B. M. 65	1.11	17.18	+0.2541	+0.2554	+0.2548	+0.3	28.4862	73.178
T. B. M. Charlieville	1.47	18.65	−1.0006	−0.9989	−0.9998	+0.5	27.4866	69.898
T. B. M. Charlieville	....	18.65	....	....	....	+0.5	27.4866	69.898
P. A. P. Stokes	0.77	19.42	+0.7299	+0.7257	+0.7268	+0.3	28.2132	72.282
P. R. P. Stokes	0.36	19.78	+0.0491	+0.0488	+0.0490	+0.3	28.2622	72.443
T. B. M. Charlieville	....	18.65	....	....	....	+0.5	27.4866	69.898
B. M. 62 (Bœuf, '98)	1.53	20.18	−0.2447	−0.2464	−0.2456	+0.5	27.2410	69.092
T. B. M. Holly Grove	1.20	21.38	+0.3631	+0.3660	+0.3646	+0.4	27.6055	70.288
T. B. M. Holly Grove	....	21.38	....	....	....	+0.4	27.6055	70.288
P. R. P. Hatch	0.03	21.41	−0.0432	−0.0433	−0.0432	+0.5	27.5624	70.147
T. B. M. Holly Grove	....	21.38	....	....	....	+0.4	27.6055	70.288
T. B. M. 66	1.31	22.69	−1.1020	−1.0983	−1.1002	+0.7	26.5056	66.680
B. M. 64 (Bœuf, '98)	0.90	23.59	+0.0264	+0.0291	+0.0278	+0.7	26.5334	66.771
P. R. P. Noble "2"	1.37	24.96	+0.2520	+0.2522	+0.2521	+0.6	26.7854	67.598
B. M. 70 (Bœuf, '98)	1.49	26.45	−0.4504	−0.4524	−0.4514	+0.7	26.3341	66.117
B. M. 71 (Bœuf, '98)	1.57	28.02	−0.0020	−0.0022	−0.0021	+0.7	26.3320	66.110
P. R. P. Elmore	0.35	28.37	+0.0945	+0.0940	+0.0942	+0.7	26.4262	66.419
P. R. P. Doucier	0.54	28.91	+0.6065	+0.6087	+0.6076	+0.6	27.0337	68.412
T. B. M. 67	0.51	29.42	−1.4734	−1.4731	−1.4732	+0.9	25.5608	63.580
T. B. M. 68	1.42	30.84	+0.1618	+0.1580	+0.1599	+0.9	25.7207	64.105
T. B. M. 69	1.38	32.22	+0.2490	+0.2477	+0.2484	+0.8	25.9690	64.919
T. B. M. 70	1.28	33.50	+0.7231	+0.7258	+0.7246	+0.7	26.6935	67.296
P. R. P. Harris	0.92	34.42	−0.6950	−0.6929	−0.6940	+0.8	25.9996	65.020
T. B. M. 71	1.31	35.76	+0.0195	+0.0182	+0.0188	+0.8	26.0184	65.081
T. B. M. 72	0.86	36.62	−0.6043	−0.6029	−0.6036	+0.9	25.4149	63.101
T. B. M. 73	1.14	37.76	−0.2763	−0.2756	−0.2760	+1.0	25.1390	62.196
T. B. M. 73	....	37.76	....	....	....	+1.0	25.1390	62.196
B. M. 81 (Bœuf, '98)	0.80	38.56	+0.5949	+0.5964	+0.5956	+0.9	25.7345	64.150
T. B. M. 73	....	37.76	....	....	....	+1.0	25.1390	62.196
P. R. P. Wheeler	0.69	38.45	+0.8877	+0.8910	+0.8894	+0.8	26.0282	65.113
T. B. M. 74	1.04	39.49	−0.7088	−0.7040	−0.7064	+1.0	25.3220	62.796
T. B. M. 75	1.08	40.57	−0.4647	−0.4602	−0.4621	+1.0	24.8596	61.279
T. B. M. 76	1.20	41.77	−0.8560	−0.8528	−0.8544	+1.2	24.0054	58.477
T. B. M. 77	1.09	42.86	−0.2546	−0.2584	−0.2565	+1.3	23.7490	57.636
P. R. P. Hebert	1.42	44.28	+1.5744	+1.5721	+1.5731	+1.0	25.2321	62.502
B. M. 91 (Bœuf, '98)	0.25	44.53	+0.5120	+0.5128	+0.5124	+0.8	25.8343	64.477
P. R. P. Lafourche	0.22	44.75	−0.7727	−0.7720	−0.7723	+1.0	25.0622	61.944
T. B. M. 78	1.06	45.81	−1.7136	−1.7154	−1.7145	+1.4	23.3481	56.321
T. B. M. 79	1.15	46.96	−1.6164	−1.6143	−1.6154	+1.7	21.7330	51.022
T. B. M. 80	1.07	48.03	−0.2485	−0.2466	−0.2476	+1.8	21.4855	50.210
T. B. M. 81	0.94	48.97	+3.6779	+3.6758	+3.6768	+1.0	25.1615	62.270
T. B. M. 82	1.26	50.23	+1.1477	+1.1530	+1.1504	+0.7	26.3116	66.143
T. B. M. 83	1.16	51.39	−2.1010	−2.0983	−2.0996	+1.2	24.2125	59.156
T. B. M. 84	0.39	51.78	+0.8673	+0.8645	+0.8659	+1.0	25.0782	61.997
T. B. M. 85	1.02	52.80	+0.0886	+0.0899	+0.0892	+1.0	25.1674	62.289
T. B. M. 86	0.83	53.63	+0.3425	+0.3439	+0.3432	+0.9	25.5105	63.415
T. B. M. 87	0.50	54.13	+0.2519	+0.2515	+0.2517	+0.9	25.7622	61.211
T. B. M. 135*	0.91	55.04	+0.2988	+0.2996	+0.2992	+0.8	26.0613	65.222
T. B. M. 135	....	55.04	....	....	....	+0.8	26.0613	65.222
T. B. M. 134*	0.83	55.87	+0.5003	+0.4996	+0.5000	+0.7	26.5612	66.862
P. R. P. Columbia	0.60	56.47	+0.4473	+0.4449	+0.4461	+0.6	27.0072	68.325
T. B. M. 135	....	55.04	....	....	....	+0.8	26.0613	65.222
T. B. M. 137*	1.26	56.30	−1.7300	−1.7323	−1.7312	+1.2	24.3305	59.544
T. B. M. 138*	1.28	57.58	+0.8527	+0.8520	+0.8524	+1.0	25.1827	62.339

*See tabulated results, Monroe to mouth of Black River, La., p. 1450, for previous elevation.

TABLE 1 D.—*Precise levels, etc.—Tabulated results*—Continued.

ARCHIBALD TO BELLEVUE AND THREE RIVERS, LA.—Continued.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Archibald.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
T. B. M. 88	1.15	58.73	−0.4180	−0.4170	−0.4175	+1.1	24.7653	60.970
P. R. P. Wade	1.79	60.52	+2.5549	+2.5564	+2.5556	+0.5	27.3203	69.353
T. B. M. 89	1.09	61.61	−2.5470	−2.5425	−2.5448	+1.1	24.7761	61.006
T. B. M. 90	1.28	62.89	−1.2134	−1.2157	−1.2146	+1.3	23.5617	57.022
T. B. M. 91	1.16	64.05	+1.3682	+1.3695	+1.3688	+1.0	24.9302	61.511
T. B. M. 92	1.11	65.16	−0.7306	−0.7292	−0.7299	+1.2	24.2005	59.117
T. B. M. 93	0.28	65.44	+0.1625	+0.1634	+0.1630	+1.2	24.3635	59.652
T. B. M. 94	1.30	66.74	−0.3342	−0.3370	−0.3356	+1.2	24.0279	58.551
T. B. M. 95	1.16	67.90	−0.8898	−0.8871	−0.8884	+1.4	23.1397	55.637
T. B. M. 96	1.08	68.98	−0.9133	−0.9110	−0.9122	+1.6	22.2277	52.645
P. R. P. Three Rivers	1.31	70.29	+0.5410	+0.5382	+0.5396	+1.5	22.7672	54.415

P. B. M. Archibald is used as initial bench. (See tabulated results, Rayville to Concordia, La., p. 1463.)
Levels were run along dirt road by T. C. Thomas, October 19 to November 15, 1899.

GILBERT TO NEW LIGHT, LA.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Gilbert.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
P. B. M. Gilbert	....	0.00	....	....	....	....	29.8791	77.748
T. B. M. 29	1.18	1.18	−0.5990	−0.6000	−0.5995	+0.1	29.2797	75.781
T. B. M. 30	0.80	1.98	−0.6650	−0.6609	−0.6629	+0.3	28.6170	73.607
T. B. M. 32	1.18	3.16	−0.1356	−0.1374	−0.1365	+0.3	28.4805	73.159
T. B. M. 33	0.94	4.10	+0.4858	+0.4902	+0.4880	+0.2	28.9684	74.760
T. B. M. 34	1.28	5.38	−0.1164	−0.1160	−0.1162	+0.2	28.8522	74.378
T. B. M. 35	1.12	6.50	+0.7330	+0.7379	+0.7354	+0.1	29.5875	76.791
T. B. M. 36	1.65	8.15	−0.7011	−0.6988	−0.7000	+0.2	28.8876	74.494
T. B. M. 37	1.26	9.41	+0.6818	+0.6838	+0.6828	+0.1	29.5703	76.734
T. B. M. 38	1.10	10.51	+0.5002	+0.4994	+0.4998	0.0	30.0700	78.374
P. B. M. Osborne	0.44	10.95	−0.0593	−0.0583	−0.0588	0.0	30.0112	78.181
B. M. 44 (Maçon, '98)	0.88	11.83	−4.8900	−4.8871	−4.8885	+1.1	25.1238	62.146
T. B. M. 40	1.41	13.24	+1.3571	+1.3569	+1.3570	+0.8	26.4805	66.597
T. B. M. 46	7.18	20.42	−2.5211	−2.5204	−2.5208	+1.3	23.9602	58.329
T. B. M. 48	2.10	22.52	+1.0454	+1.0531	+1.0493	+1.1	25.0093	61.770
T. B. M. 51	3.87	26.39	+2.0753	+2.0786	+2.0769	+0.6	27.0857	68.583
B. M. 39 (Tensas, '98)	0.47	26.86	+0.8543	+0.8529	+0.8536	+0.4	27.9391	71.383
T. B. M. 52	0.49	27.35	−2.1559	−2.1531	−2.1545	+0.9	25.7851	64.316
P. B. M. New Light	1.25	28.60	+2.2567	+2.2574	+2.2571	+0.4	28.0417	71.719
B. M. 38 (Tensas, '98)	0.13	28.73	−0.7263	−0.7267	−0.7265	+0.6	27.3154	69.336

Levels were run along dirt road by T. C. Thomas, October 5 to 16, 1899.
P. B. M. Gilbert is used as initial bench. (See tabulated results, Rayville to Concordia, La., p. 1463.)

SHREVEPORT TO JETERS LANDING, LA.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Shreveport.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
P. B. M. 46	....	0.0	....	....	....	....	65.8447	195.744
P. B. M. 1	15.7	15.7	+ 8.2741	+ 8.2635	+ 8.2688	−1.0	74.1125	222.868
P. B. M. 2	18.2	33.9	+ 6.5432	+ 6.5536	+ 6.5484	−1.4	80.6605	244.352
P. B. M. 3	2.0	35.9	−18.6560	−18.6663	−18.6612	+0.8	62.0015	183.135
P. B. M. 4	7.6	43.5	+ 4.2930	+ 4.3114	+ 4.3022	−0.1	66.3028	197.246

P. B. M. 46 is used as initial bench. (See tabulated results, Delta to Coushatta, La., p. 1457.)
Levels were run along dirt road by R. S. Buck, December 15, 1890, to January 22, 1891.

TABLE 1 D.—*Precise levels, etc.—Tabulated results*—Continued.

JONESVILLE TO VIDALIA, LA., AND NATCHEZ, MISS.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Jonesville.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
P. B. M. 4		0.00					22.6462	54.018
P. B. M. 3	0.38	0.38	- 0.8617	-0.8482	-0.8550	+0.1	21.7913	51.213
P. B. M. 3		0.38				+0.1	21.7913	51.213
Gauge B. M. A	0.27	0.65	+ 1.1850	+1.1829	+ 1.1839	-0.1	22.9750	55.097
Gauge B. M. C	0.06	0.71	- 1.9374		- 1.9374	+0.3	21.0380	48.711
Gauge B. M. B	0.03	0.74	+ 0.5577		+ 0.5577	+0.2	21.5956	50.571
P. B. M. 3		0.38				+0.1	21.7913	51.213
T. B. M. 27	0.00	0.38	+ 0.9000	+ 0.9013	+ 0.9006	0.0	22.6918	54.167
T. B. M. 20	10.24	10.62	+ 0.9817	+ 0.9753	+ 0.9785	-0.2	23.6701	57.377
T. B. M. 19	2.01	12.63	+ 0.5451	+ 0.5482	+ 0.5466	-0.4	24.2165	59.170
P. B. M. 2	1.75	14.38	- 0.8333	- 0.8298	- 0.8315	-0.2	23.3852	56.442
T. B. M. 9	14.43	28.81	+ 2.4113	+ 2.3964	+ 2.4038	-0.6	25.7884	64.607
T. B. M. 1	11.28	40.09	- 0.5483	- 0.5458	- 0.5471	-0.4	25.2415	62.582
T. B. M. 1		40.09				-0.4	25.2415	62.582
M. R. C. Stone $\frac{1}{3}{}^{2}$	0.00	40.09	- 0.9360	- 0.9406	- 0.9383	-0.4	24.3034	59.455
M. R. C. Stone $\frac{1}{4}{}^{2}$	- 1.25	38.84	- 0.4385	- 0.4318	- 0.4351	-0.3	23.8684	58.027
T. B. M. 1		40.09				-0.4	25.2415	62.582
P. B. M. LXIII (C. and G. S.)	0.58	40.67	- 0.3962	- 0.3947	- 0.3954	-0.5	24.8462	61.235
P. B. M. LXIII (C. and G. S.)		40.67				-0.5	21.8462	61.235
P. B. M. LXII (C. and G. S.)	0.90	41.57	+ 0.6655	+ 0.6676	+ 0.6666	-0.6	25.5127	63.422
P. B. M. LXI (C. and G. S.)	2.10	43.67	- 0.5549	- 0.5481	- 0.5515	-0.5	24.9613	61.613
P. B. M. LXIV (C. and G. S.)			+ 0.9937	+ 0.9839	+ 0.9883	-0.7	25.9494	64.855
P. B. M. LXIII (C. and G. S.)		40.67				-0.5	24.8462	61.235
B. M. (1858)	0.10	40.77	+ 0.9176	+ 0.9182	+ 0.9179	-0.7	25.7639	64.246
C.-H. Pedestal	0.00	40.77	+ 0.6580	+ 0.6587	+ 0.6584	-0.8	26.4222	66.406
P. B. M. LXIII (C. and G. S.)		40.67				-0.5	24.8462	61.235
Polk 2	1.40	42.07	+ 6.3774	+ 6.3741	+ 6.3758	-1.8	31.2207	82.149
Polk 2		42.07				-1.8	31.2207	82.149
B. M. No. 3 (Babbit)	0.00	42.07	- 0.5374	- 0.5374	- 0.5374	-1.7	30.6834	80.386
B. M. Ewens N	0.10	42.17	- 2.8816	- 2.8812	- 2.8814	-1.1	27.8026	70.985
Polk 2		42.07				-1.8	31.2207	82.149
B. M. Babbit (1879)	0.50	42.57	+34.3088	+34.3090	+34.3089	-8.6	65.5228	194.688
P. B. M. 1	0.10	42.67	+ 0.1634	+ 0.1630	+ 0.1632	-8.7	65.6859	195.222
Melvin (1879)	0.30	42.97	+ 6.2635	+ 6.2622	+ 6.2628	-9.9	71.9475	215.766

P. B. M. 4 is used as initial bench. (See tabulated results, Monroe to mouth of Black River, La., p. 1450.)

From P. B. M. 3 to T. B. M. 9 was run along the Natchez, Red River and Texas Railway track. From T. B. M. 9 to P. B. M. LXIII (C. and G. S.) was run along dirt road.

Levels were run by Walter H. Polk, November 21 to December 28, 1893.

Elevation of P. B. M. LXI, 18.7353; LXII, 19.2866, and LXIV, 19.7233 meters, Gulf level, by the Coast and Geodetic Survey. (See their report for 1898–99, Appendix 8, p. 482.)

BARBIN TO MOUTH OF BLACK RIVER, LA.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Barbin.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
T. B. M. 53		0.00					30.3598	79.324
T. B. M. 116	0.55	0.55	+0.7481	+0.7488	+0.7484	-0.2	31.1080	81.780
T. B. M. 52	0.78	1.33	-1.2426	-1.2382	-1.2404	+0.1	29.8679	77.711
T. B. M. 99	0.81	2.14	-0.3697	-0.3700	0.3698	+0.2	29.4982	76.498
T. B. M. 98	0.69	2.83	-5.7873	-5.7913	-5.7893	+1.5	23.7102	57.509
T. B. M. 51a	0.59	3.42	0.1786	-0.1756	-0.1771	+1.5	23.5331	56.927
P. B. M. Barbin	0.00	3.42	+0.3205	+0.3212	+0.3208	+1.4	23.8538	57.980
T. B. M. 100	0.98	4.40	-0.0202	-0.0204	-0.0203	+1.4	23.8335	57.913
T. B. M. 101	1.40	5.80	-0.2230	-0.2210	-0.2220	+1.5	23.6116	57.185

TABLE 1 D.—*Precise levels, etc.—Tabulated results*—Continued.

BARBIN TO MOUTH OF BLACK RIVER, LA.—Continued.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Barbin.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
T. B. M. 102	1.29	7.09	−0.0610	−0.0589	−0.0599	+1.5	23.5517	56.988
T. B. M. 103	0.87	7.96	−0.2157	−0.2140	−0.2148	+1.6	23.3370	56.284
T. B. M. 104	1.37	9.33	−0.0160	−0.0135	−0.0148	+1.6	23.3222	56.236
T. B. M. 105	1.25	10.58	+0.2450	+0.2407	+0.2428	+1.5	23.5649	57.032
T. B. M. 107	2.16	12.74	−1.6602	−1.6593	−1.6597	+1.9	21.9056	51.588
T. B. M. 108	1.14	13.88	+0.4740	+0.4767	+0.4754	+1.8	22.3809	53.147
P. B. M. White	0.69	14.57	+0.4046	+0.4032	+0.4039	+1.7	22.7847	54.472
T. B. M. 109	0.35	14.92	−0.9121	−0.9097	−0.9109	+1.9	21.8740	51.484
T. B. M. 112	2.32	17.24	+0.0995	+0.0977	+0.0986	+1.9	21.9726	51.808
T. B. M. 113	0.97	18.21	+0.1494	+0.1510	+0.1502	+1.8	22.1227	52.300
T. B. M. 114	1.00	19.21	−0.6228	−0.6241	−0.6234	+2.0	21.4995	50.256
T. B. M. 115	0.66	19.87	−0.2707	−0.2682	−0.2694	+2.0	21.2301	49.372
T. B. M. 117	0.86	20.73	+0.4215	+0.4247	+0.4231	+1.9	21.6531	50.760
T. B. M. 122	4.05	24.78	−0.7006	−0.7091	−0.7048	+2.1	20.9486	48.448
T. B. M. 123	1.17	25.95	−1.6150	−1.6102	−1.6126	+2.4	19.3363	43.158
T. B. M. 125	1.01	26.96	+1.0907	+1.0892	+1.0899	+2.2	20.4260	46.734
T. B. M. 126	1.33	28.29	+0.0705	+0.0730	+0.0718	+2.2	20.4978	46.968
T. B. M. 127	1.11	29.40	−0.0950	−0.0975	−0.0962	+2.2	20.4016	46.654
T. B. M. 128	1.04	30.44	−0.1333	−0.1352	−0.1342	+2.2	20.2674	46.213
T. B. M. 129	0.96	31.40	+0.3394	+0.3389	+0.3391	+2.2	20.6065	47.326
T. B. M. 130	0.81	32.21	+0.1276	+0.1260	+0.1268	+2.1	20.7332	47.742
T. B. M. 131	1.01	33.22	+0.2853	+0.2858	+0.2856	+2.1	21.0188	48.678
T. B. M. 132	0.96	34.18	+0.0730	+0.0744	+0.0737	+2.1	21.0925	48.920
T. B. M. 36	0.89	35.07	+0.1253	+0.1261	+0.1257	+2.0	21.2181	49.332
P. B. M. 12a	0.27	35.34	−0.0053	−0.0050	−0.0052	+2.0	21.2129	49.309

T. B. M. 53 is used as initial bench. (See tabulated results, Grand Bend to Smithland, La., p. 1459.)

P. B. M. 12a is used as closing bench; elevation, 21.1120 meters by line from Monroe to mouth of Black River, La.

Levels were run along dirt road by T. C. Thomas, November 20 to December 9, 1899.

FRIARS POINT TO CLARKSDALE, MISS.

Bench.	Distance.		Difference of elevation.			Total rod correction.	Elevation above Cairo datum.	Elevation above Gulf level.*
	Between benches.	From Friars Point.	Forward.	Back.	Mean.			
	Kilometers.	*Kilometers.*	*Meters.*	*Meters.*	*Meters.*	*Millimeters.*	*Meters.*	*Feet.*
P. B. M. **Friars Point II**	....	0.0	....	....	....	....	61.2991	180.830
P. B. M. **Friars Point III**	....	0.0	−1.4541	−1.4559	−1.4550	+0.3	59.8444	176.058
P. B. M. **Coahoma**	11.0	11.0	+0.4269	+0.4246	+0.4257	+0.2	60.2700	177.454
P. B. M. **Clover Hill**	8.8	19.8	−1.3810	−1.3912	−1.3861	+0.4	58.8841	172.907
P. B. M. **Lyon**	8.4	28.2	+0.1634	+0.1620	+0.1627	+0.4	59.0468	173.441
T. B. M. 25	1.1	29.3	−1.0027	−1.0060	−1.0043	+0.6	58.0427	170.147
T. B. M. 26	1.0	30.3	+0.8199	+0.8210	+0.8205	+0.4	58.8630	172.833
T. B. M. 27	1.0	31.3	−0.7390	−0.7400	−0.7395	+0.5	58.1236	170.412
P. B. M. **Clarksdale I**	0.8	32.1	+0.8742	+0.8775	+0.8759	+0.4	58.9994	173.286
P. B. M. **Clarksdale II**	0.0	32.1	−0.3775	−0.3799	−0.3787	+0.4	58.6207	172.043
P. B. M. **Clarksdale III**	0.0	32.1	+0.1160	+0.1149	+0.1154	+0.4	58.7361	172.421

P. B. M. Friars Point II is used as initial bench. (See Report of Chief of Engineers, 1879, p. 1942; and for 1883, footnote, p. 2177.)

Levels were run along track of the Yazoo and Mississippi Valley Railway by T. C. Thomas, October 1 to 15, 1894.

TABLE 1 E.—*Precise levels, etc.—Descriptions and elevations.*

NOTE 1.—All bench-mark monuments referred to as pipestone benches consist of pieces of limestone 46 centimeters square and 15 centimeters thick, marked $\overset{\text{U S}}{\underset{\text{B M}}{\text{o}}}$ with spherical-headed copper bolts leaded in upper faces and buried 1.2 meters under ground, access being given through 12-centimeter iron pipes set on top. Each pipe has a cast-iron cap, fastened by a horizontal bolt through cap and pipe. The cap has a small boss and the letters $\overset{\text{USE}}{\underset{\text{B M}}{\text{o}}}$ raised on top. Elevations apply to the top of the bolt in the underground stone. Elevation of boss of pipe cap can be found in any case by adding 1.24 meters to elevation of copper bolt.

NOTE 2.—All bench-mark monuments referred to as pipe-flange benches consist of 4-centimeter gas pipes about 1.6 meters long, capped at upper end and having a 12-centimeter circular flange attached near lower end by lock nuts. Monuments set with about 0.1 meter above ground surface. Flanges are surrounded in the usual case by a matrix of neat cement, approximately doubling the bearing area of the monument. Elevations apply to the top of cap.

MONROE, LA., TO LITTLE ROCK, ARK.

P. B. M. 27.—Pipestone bench in northwest corner of court-house yard at Monroe, La. Bench is in line of oak trees parallel to court-house front and midway between two lines of oaks parallel to north wall, 45 meters west and 9 meters north of northwest corner of building. Elevation, 29.9638.

P. B. M. 25.—At Monroe, Ouachita Parish, La. Is cross cut in northwest corner of iron-roller plate, set on granite cap of concrete pier with sheet-iron casing, at north side of east end of V., S. and P. Ry. bridge over Ouachita River. Elevation, 30.7936.

P. B. M. 24.—Pipestone bench in grass plot south of roundhouse at Vicksburg, Shreveport and Pacific shops, Monroe, Ouachita Parish, La. Bench is in southwest corner of plot, 8 meters north of center line of track and 2.4 meters east of east wall of office building. Elevation, 27.9831.

T. B. M. 96.—At Monroe, Ouachita Parish, La. Boat spike in root of a 0.3-meter maple on south side of Washington street, opposite the parish hospital and about 40 meters north of corner of Eleventh street. Elevation, 28.7795.

T. B. M. 95.—Boat spike in root of a gum, 8 meters south of road from Logan Place to Monroe and about 100 meters below dwelling on Bright Oak Place, Ouachita Parish, La. Elevation, 28.8451.

P. R. P. Pargoud.—Pipestone bench on top of Indian mound, about 100 meters below mouth of Bayou De Siard, Ouachita Parish, La. It is about 100 meters east of bank of Ouachita River and 50 meters south of south bank of Bayou De Siard, and about 200 meters above gin on Pargoud Place. Elevation, 37.6713.

T. B. M. 94a.—Boat spike in root of a pin oak on the Pargoud Indian mound. Elevation, 38.2294.

P. R. P. Zeph.—Pipestone bench on the Bank Smith Place, Ouachita Parish, La.; in the west edge of cultivated field about 50 meters northeast of an abandoned cabin and 60 meters east of east bank of river. It is 250 meters south of wagon road and witnessed by two triangular blazed trees, as follows: 0.8-meter cottonwood, 72° 17′, 45 meters; 0.4-meter redwood, 159° 20′, 12 meters. Elevation, 30.2511.

T. B. M. 87.—Boat spike in root of a 0.7-meter white oak, on west side of main road and 75 meters from southeast corner of Zeph Lake, Ouachita Parish, La., 150 meters east from river at bight of bend. Elevation, 28.6218.

T. B. M. 86.—Boat spike in root of a 0.6-meter water oak on east side of road about 50 meters from where it leaves Horseshoe Lake, Ouachita Parish, La., 500 meters below Negro church, "Pilgrims' Rest." Elevation, 28.0876.

P. R. P. Rock Row.—Pipestone bench at Rock Row Shoals, Ouachita Parish, La., on Mrs. Seal's place, about 40 meters north of left bank of Ouachita River, and 30 meters north of a boundary fence about Mrs. Seal's place. It is 100 meters west (upstream) from division fence between Mrs. Seal's and Colonel Stubbs's upper "Lonewa Place." It is 25 meters, on an azimuth 305° 34′, from the central cedar (not blazed) in a clump of three cedar trees, each about 0.3 meter in diameter and badly seared by fire. Two triangular blazed reference trees, viz: One meter chinaberry, 310°, 4 meters; 0.6 meter walnut, 53° 33′, 39 meters. Elevation, 29.5221.

T. B. M. 83.—At Rock Row Shoals, Ouachita Parish, La. Boat spike in root of a chinaberry in yard on Taylor Place, and 30 meters north of left bank of Ouachita River. Elevation, 30.8059.

T. B. M. 81.—Boat spike in root of a 0.3-meter hickory on main road where it approaches Place Lake, Ouachita Parish, La., about 20 meters above cabin on north side of road and near north corner of lake. Elevation, 30.2624.

P. R. P. Glendora.—Pipestone bench; is on the division line between the Hugh Young and Glendora places in Ouachita Parish, La. It is about 460 meters southeast of east bank of Ouachita River where the property line strikes same. The bench is midway between two ditches where they unite. Elevation, 30.8990.

T. B. M. 79.—Boat spike in root of a 0.3-meter water oak on west side of road, 7 meters from east bank of Ouachita River, and 60 meters from Hugh Young's yard gate, Ouachita Parish, La. Elevation, 32.2192.

T. B. M. 77.—Boat spike in root of a 0.2-meter sycamore in field, about 400 meters below Smith's residence, and behind cabin on east side of road, and 200 meters below lane. Elevation, 31.6377.

T. B. M. 75.—Boat spike in root of a walnut on right side of road, 1,200 meters below mouth of Bayou Bartholomew and nearly opposite sixth cabin on left; about 200 meters above storehouse at corner of road and lane. Elevation, 33.1840.

P. R. P. Parkeville.—Pipestone bench at Parkeville, Morehouse Parish, La. It is in the northeast corner of yard to house occupied by Bob Tucker (colored) and belonging to James Steele. It is 40 meters back from right bank of Bayou Bartholomew and 200 meters above its mouth. It is 3 meters east of east end of house, and 12 meters north of "L" to house. Witnessed by two blazed trees as follows: 0.6-meter chinaberry S. 35° W., 6 meters, and 0.5-meter chinaberry N. 80° W., 4 meters. Elevation, 29.7302.

T. B. M. 74.—Boat spike in root of a chinaberry in same yard and 3 meters from P. R. P. Parkeville. Elevation, 30.9517.

P. R. P. Cashill.—Pipestone bench on left bank and 250 meters above the mouth of Mill Bayou, Union Parish, La. It is about 20 meters above a marked bend of the top bank of bayou, and witnessed by three triangular blazed trees, as follows: 0.7-meter sweet gum 154° 20′, 14 meters; 0.4-meter sweet gum 206° 47′, 13 meters; 0.8-meter red oak 342° 05′, 15 meters. Elevation, 27.9416.

T. B. M. 70.—Boat spike in root of a 0.3-meter water oak on chain line cut, about 80 meters above P. R. P. Cashill, and about 50 meters from nearest point of Mill Bayou. Elevation, 27.9830.

P. R. P. Fishtrap.—Pipestone bench, about 500 meters below Fishtrap Shoals, Union Parish, La. It is in woods about 80 meters west of west bank of Ouachita River and witnessed by three triangular blazed trees as follows: 0.5 meter red oak 24° 30′, 7.5 meters; 0.4-meter water oak 228° 44′, 8.5 meters; 0.5-meter water oak 310° 41′, 70 meters. Elevation, 27.3685.

P. R. P. Alabama.—Pipestone bench at Alabama Landing, Union Parish, La. It is on the south side of road, on outside of fence inclosing stock yard, 50 meters from west corner and 80 meters from east corner, and 45 meters southwest of store. Witnessed by three triangular blazed trees, as follows: 0.4-meter post oak 78° 11′, 17.3 meters; 0.7-meter gum 197° 43′, 29.3 meters, and 0.4-meter post oak 302° 27′, 16.8 meters. Elevation, 27.3584.

T. B. M. 63.—Boat spike in root of 0.6-meter elm, about 5 meters back from warehouse at Alabama Landing, Union Parish, La. Elevation, 28.4576.

T. B. M. 62.—Boat spike in root of a 0.35-meter sweet gum about 200 meters from river, near edge of field and in road to Alabama Landing. Elevation, 28.0951.

P. R. P. Frank Pierre.—Pipestone bench, on left bank and about 500 meters above mouth of Frank Pierre Creek, Union Parish, La. It is 250 meters west of west bank of Ouachita River and about 10 meters above mouth of small slough. Witnessed by three triangular blazed trees as follows: 0.6-meter post oak 109°, 10 meters; 0.4-meter pecan 223° 18′, 23 meters; and 0.6-meter post oak 269° 56′, 23 meters. Elevation, 23.1974.

T. B. M. 59.—Boat spike in root of a 0.4-meter white oak about 80 meters from Frank Pierre Creek, and 175 meters from Ouachita River. Elevation, 23.6271.

P. R. P. Shiloh.—Pipestone bench about 200 meters above Shiloh Shoals, Union Parish, La. It is about 90 meters west of west bank of river and 100 meters from camping grounds on bank of river. Witnessed by three triangular blazed trees, as follows: 0.3-meter post oak 59° 29′, 6 meters; 0.9-meter white oak 148° . 24′, 12 meters; and 0.4 meter white oak 309° 48′, 15 meters. Elevation, 23.4469.

T. B. M. 55.—Boat spike in root of a 0.4-meter pignut hickory, about 30 meters above P. R. P. Shiloh, and 80 meters from west bank of Ouachita River. Elevation, 24.7555.

T. B. M. 53.—Boat spike in root of a 0.4-meter white oak about 150 meters below south bank of Fish Lake, and 30 meters south of road to Ouachita River. Elevation, 24.1323.

P. R. P. Lake.—Pipestone bench, about 250 meters below Lake Landing, Union County, Ark., 16 meters east of east bank of Pools Bayou, and 80 meters southwest of west bank of Ouachita River, and about 250 meters southeast of boat channel connecting Lake St. Mary and Ouachita River. Elevation, 24.1620.

T. B. M. 49.—Boat spike in root of a 0.9-meter white oak, 75 meters south of P. R. P. Lake, and 15 meters north of outlet to Lake St. Mary. Elevation, 25.6051.

T. B. M. 48.—Boat spike in root of a 0.4-meter pignut hickory, about 250 meters above outlet (steamer channel) of Lake St. Mary, and 50 meters from east shore of lake. Elevation, 23.9569.

T. B. M. 46.—Boat spike in root of a 1-meter white oak, 100 meters from west bank of river, and 200 meters above Grand Mary Landing. Elevation, 26.2345.

P. R. P. Lapile.—Pipestone bench about 1.6 kilometers above Bayou Lapile, Union County, Ark. It is in woods about 75 meters west of west bank of Ouachita River, and witnessed by three triangular blazed trees, as follows: 0.5-meter post oak 203° 23′, 9 meters; 0.3-meter post oak 247° 15′, 5 meters; 0.7-meter post oak 341° 37′, 7 meters. Elevation, 24.8834.

T. B. M. 44.—Boat spike in root of a 0.3-meter oak, 20 meters east of P. R. P. Lapile. Elevation, 26.0742.

P. R. P. Belle Point.—Pipestone bench, about 200 meters southwest of Ouachita Belle Landing, Union County, Ark. Is in woods about 175 meters south of road leading back from river. Witnessed by three triangular blazed trees, as follows: 0.5-meter sweet gum 71° 47′, 16 meters; 0.2-meter white oak 164° 25′; 5 meters; and a 0.4-meter Spanish oak 273° 54′, 4.5 meters. Elevation, 25.7638.

T. B. M. 39.—Boat spike in root of a white oak, 200 meters southwest from Belle Point Landing, and 5 meters from P. R. P. Belle Point. Elevation, 26.8596.

P. R. P. Eutaw.—Pipestone bench about 550 meters below Eutaw Shoals, Union County, Ark. It is in the woods about 60 meters west of west bank of Ouachita River, on bank of small slough, 60 meters south of an old road and witnessed by three triangular blazed trees, as follows: 0.5-meter sweet gum 29°; 0.9-meter water oak 182° 40′; and 0.7-meter sweet gum 261° 21′. Elevation, 28.2320.

T. B. M. 32a.—Boat spike in root of a 0.5-meter white oak, 100 meters west of P. R. P. Eutaw, and 30 meters southeast of road. Elevation 29.1259.

P. R. P. Jacks Island.—Pipestone bench opposite Jacks Island, Union County, Ark. It is on the east side of an old road, 100 meters south of river bank, and opposite lower end of gravel bar on lower end of Jacks Island. Witnessed by 3 triangular blazed trees as follows: 0.5-meter gum 181°, 5 meters; 0.6-meter gum 286°, 6 meters; and 0.4-meter red oak 355°, 5 meters. Elevation, 29.4342.

T. B. M. 25a.—Boat spike in root of a 0.7-meter white oak, 5 meters from P. R. P. Jacks Island, and 1 meter east of old road. Elevation, 30.9940.

P. R. P. Careyville.—Pipestone bench at Careyville, Union County, Ark. It is on side of lane and about 65 meters from the end, 160 meters southeast of Ouachita River, and 150 meters south of warehouse. Elevation, 31.1707.

T. B. M. 23.—Spike in root of a 0.2-meter pine on roadside about 70 meters southwest of P. R. P. Careyville. Elevation, 32.2826.

P. R. P. Pigeon Hill.—Pipestone bench at Pigeon Hill Landing, Union County, Ark. It is on hillside, 15 meters from foot of slope and about 75 meters S. 15° W. from warehouse at landing. Witnessed by three triangular blazed trees, as follows: 0.7-meter pine, N. 45° E., 4 meters; 0.4-meter pine, S. 30° E., 5 meters; and 0.5-meter pine, S. 45 W., 4 meters. Elevation, 33.9698.

T. M. B. 18.—Boat spike in root of 0.3-meter sweet gum on upper side and 1 meter from road at Pigeon Hill, Union County, Ark., about 75 meters southwest from old warehouse, and 15 meters northwest from P. R. P. Pigeon Hill. Elevation, 31.3169.

P. R. P. Fletcher.—Pipestone bench about 500 meters below Fletchers Landing, Union County, Ark. It is in edge of woods on east side of field and about 40 meters south of river. Witnessed by three triangular blazed trees as follows: 0.4-meter water oak 208° 41′, 14.5 meters; 0.6-meter white oak 271° 30′, 20.5 meters, and 0.7-meter hickory 309°, 17.5 meters. Elevation, 31.8739.

T. B. M. 15.—Boat spike in root of a 0.6-meter white oak 600 meters east from Fletchers Landing, Union County, Ark., and 40 meters east of P. R. P. Fletcher. Elevation, 32.3128.

T. B. M. 14.—Boat spike in root of a 0.9-meter water oak, about 30 meters from left top bank of Ouachita River, opposite Fletchers Landing. The tree has the letters U S cut on it above bench. Elevation, 31.2227.

P. R. P. Franklin.—Pipestone bench 250 meters northwest of mouth of Franklin Bayou, Union County, Ark. It is 120 meters southwest of Ouachita River, 175 meters north of bayou at its nearest point, and on first ridge above the bayou. Witnessed by three triangular blazed trees as follows: 0.5-meter water oak 14° 45′, 6 meters; 0.7-meter sweet gum 97° 06′, 12 meters, and 0.7-meter white oak 258° 03′, 4 meters. Elevation, 28.8008.

T. B. M. 8.—Boat spike in root of a 0.7-meter white oak, 10 meters below P. R. P. Franklin. Elevation, 29.1654.

T. B. M. 7.—Boat spike in root of a 0.4-meter water oak, 600 meters above mouth of Franklin Bayou, Union County, Ark., and 10 meters from right bank of Ouachita River. Elevation, 30.6880.

P. R. P. Bell field.—Pipestone bench about 5.6 kilometers below Champagnolle, Union County, Ark. Is on south side of Bell's field (uncultivated), and about 150 meters from west end. It is about half way between road leading to Champagnolle and a neighborhood road, and 470 meters from river bank. Elevation, 30.8217.

T. B. M. 1.—Boat spike in root of a 0.3-meter persimmon, in valley about 80 meters above Johnsons Spring, Union County, Ark., 4 meters north of ravine and 150 meters south of Langford's house. Elevation, 39.3370.

P. R. P. Champagnolle—Pipestone bench at Champagnolle Landing, Union County, Ark. It is between forks of small valley entering river immediately below store, about 150 meters back from river bank, and 5 meters from foot of slope. Witnessed by two triangular blazed trees, as follows: 0.5-meter black oak N. 20° E., 4 meters; 0.5-meter black oak N. 15° W., 5 meters. Elevation, 35.8669.

P. R. P. Eldorado.—Pipestone bench at Eldorado Landing, Union County, Ark. Is in west corner of yard of R. T. Goodwin in prolongation of south wall of dwelling and 7 meters west of west wall. Witnessed by three trees, as follows: 0.3-meter chinaberry N. 10° E., 3 meters; 0.1-meter cedar S. 80° E., 8 meters; 0.2-meter cedar S. 10° W., 5 meters. Elevation, 32.9798.

P. R. P. Smackover.—Pipestone bench on right bank of river, 25 meters below mouth of Smackover Creek, Union County, Ark., and 20 meters from bank, and 5 meters from head of slash leading back to swamp. Witnessed by three blazed trees, as follows: 0.6-meter sweet gum 196°, 6 meters; 0.9-meter sweet gum 86°, 3 meters; 0.8-meter sweet gum 324°, 5 meters. Elevation, 32.5399.

P. R. P. Leppard.—Pipestone bench at Leppards Camp, Calhoun County, Ark., 45 meters back from left bank of Ouachita River. Is on line with upstream side of and 30 meters back from upper back corner of cabin. Witnessed by four blazed trees, as follows: 1-meter sweet gum 160°, 3 meters; 0.6-meter white oak 258°, 4 meters; 0.8-meter sweet gum 355°, 14 meters; and 0.4-meter holly 101°, 10 meters. Elevation, 33.7402.

T. B. M. 18a.—Spike in root of a 0.4-meter sycamore, about 40 meters northwest from P. A. P. Leppard. Elevation, 32.7019.

P. R. P. Little Bay.—Pipestone bench on left top bank of river and left top bank of Little Bay at mouth of Little Bay, Calhoun County, Ark. Is 4 meters back from main bank. There is a second bank about 40 meters wide. Witnessed by four blazed trees, as follows: 0.5-meter black gum 99°, 3 meters; 0.5-meter sweet gum 170°, 3½ meters; 0.4-meter holly 278°, 11 meters; and 1.4-meter black oak 308°, 17 meters. Elevation, 33.7412.

T. B. M. 13.—Is inside of 0.5-meter holly about 30 meters south of large bayou, and about 150 meters above bayou entering through right bank of Ouachita River below Little Bay, Calhoun County, Ark. Elevation, 35.2231.

T. B. M. H.—Is in root of the largest of a cluster of sweet gums, 10 meters northwest from northwest corner of upper warehouse at Newport Landing, Ouachita County, Ark. Elevation, 36.4745.

P. R. P. Beech Hill.—Pipestone bench, at foot of Beech Hill, Ouachita County, Ark., about 60 meters northwest of where hills meet the river bank, and 100 meters northwest of shanty on top of hill. Witnessed by three triangular blazed trees, as follows: 1.3-meter black gum N. 2½ meters, 0.7-meter beech W. 8 meters, 0.9-meter beech SW. 13 meters. Elevation, 34.5132.

P. R. P. Walnut Hill.—Pipestone bench 25 meters from foot of Walnut Hill, Ouachita County, Ark., 25 meters south of right bank of bayou and 225 meters west of where hills join river bank. Witnessed by three triangular blazed trees, as follows: 1.5-meter tupelo gum, 5 meters; 0.25-meter hackberry, 13 meters, and 0.25 meter elm, 8 meters. Elevation, 33.6962.

T. B. M. 5.—In root of 0.15-meter lind tree about 10 meters from right bank of river where Walnut Hills join river bank and 10 meters west of large gum tree. Elevation, 37.8127.

P. R. P. Frenchport II.—Pipe-flange bench 125 meters back from river bank at Frenchport, Ouachita County, Ark., and 100 meters south of old dwelling. Is on top of small knoll and midway between two pine trees having triangular blazes. Pine to west of bench is 0.9 meter diameter and 2 meters distant; pine to east of bench is 0.7 meter diameter and 2 meters distant. Elevation, 43.6692.

P. R. P. Frenchport I.—Pipe-flange bench 150 meters back from river bank at Frenchport, Ouachita County, Ark., 1 meter north of north wall of old dwelling and 25 meters west of west wall; midway between two large triangular blazed gum trees, first north 1.2 meters diameter, 2 meters distant; second south 1 meter diameter. Elevation, 40.9287.

P. B. M. Elliott.—Pipe-flange bench at southwest corner of north store building, at Elliott, Ouachita County, Ark. Bench is in line with west or front wall of store, and 3 meters from south wall. Elevation, 83.6131.

Gauge B. M. A. (*Ewens 1890*).—Is small cross cut in granite sill of east door of George L. Ritchie's store, north side of Main street and about 75 meters east of St. L. S.-W. Railway track at Camden, Ouachita County, Ark. Elevation by St. Louis Southwestern Railway Company, 131.37 feet. Elevation, 46.8734.

P. B. M. Camden IV.—Is cross cut on stone cap to iron tubular pier under west end of north truss of St. Louis Southwestern Railway bridge over Ouachita River, near Camden, Ouachita County, Ark. Bench is in line with west edge of rest plate and 344 millimeters north of north edge. Bench is marked $\overset{\text{U S}}{\underset{\text{B M}}{\text{x}}}$. Elevation, 41.2473.

P. R. P. Camden III.—Is a bench mark of St. Louis Southwestern Railway at Camden, Ouachita County, Ark. Is top of small pipe set vertically 266 meters west of bridge and 10 meters west of track, and 4 meters from foot of embankment. The small pipe is inside of a 0.1 meter pipe which reaches 0.25 meter above smaller pipe. Elevation, 38.9966.

P. B. M. Camden II.—Is cross cut on south edge of second step from bottom of a flight of 8 stone steps leading to entrance on west side of court-house at Camden, Ouachita County, Ark. Bench is 0.08 meter from south end of steps and 0.15 meter from west edge. Elevation, 66.9329.

P. R. P. Camden I.—Pipe-flange bench in southwest corner of yard of Shiloh Methodist Church (colored), at Camden, Ouachita County, Ark. Bench mark is 0.5 meter south of fence of yard and 0.7 meter from west fence, 4 meters north from north end of cotton shed of Camden compress, and 10 meters east of track to compress. Elevation, 48.4008.

P. B. M. Lester.—Pipe-flange bench 200 meters east of Lester, Ouachita County, Ark., and 15 meters south of track. It stands opposite milepost 452 in edge of clearing along railroad right of way. Elevation, 40.8566.

P. B. M. Chidester.—Pipe-flange bench in southwest corner of yard of Dr. Tidwell, 20 meters north of north wall of depot at Chidester, Ouachita County, Ark., and 22 meters east of east wall. Also 1 meter north of south fence of yard, 0.2 meter east of west fence. Witnessed by two triangular blazed trees, as follows: 0.3-meter oak NW. 6 meters; and 0.2-meter white oak E. 5-meters. Elevation, 76.3963.

P. B. M. Little Missouri.—Is cross cut on top of stone pier at north end (left bank) of St. Louis, Iron Mountain and Southern Railway bridge over the Little Missouri River and in Clark County, Ark. Bench is midway between rails of track and 0.1 meter from south edge of capstone of pier. On edge of capstone is a V cut with vertex pointing to bench. Bench is marked $\overset{\text{U S}}{\underset{\text{B M}}{\text{x}}}$ Elevation, 56.7146.

P. B. M. Wheelen.—Pipe-flange bench in line with north wall of depot at Wheelen, Clark County, Ark., and 30 meters east of east wall. Bench is 30 meters south of south wall of store and 1 meter west of west wall; is 1 meter west of fence around garden inclosure just south of store and 4 meters north of southwest corner of garden. Elevation, 83.1009.

P. B. M. Gurdon II.—Pipe-flange bench in northwest corner of small park inclosure immediately west of depot at Gurdon, Clark County, Ark. Is 25 meters west of west wall of depot and 3 meters north of north wall. Elevation, 69.6848.

P. B. M. Gurdon I.—Pipe-flange bench in line with west wall of depot and 20 meters south of south wall, and immediately in front of Hall Hotel, at Gurdon, Clark County, Ark. Elevation, 69.8362.

P. B. M. Smithton.—Pipe-flange bench at edge of railway right of way and back of milepost 423. Is on right-hand side of track going to Smithton, Clark County, Ark., and 1.2 kilometers northeast of station. Bench is 0.5 meter from fence along right of way. Elevation, 69. 0446.

P. B. M. Curtis.—Pipe-flange bench at intersection of line of south wall of depot at Curtis, Clark County, Ark., with front line of stores standing northwest of depot. Bench is 25 meters west of west wall of depot and 15 meters south of south wall of nearest store to north. Elevation, 62.6038.

P. B. M. Gum Springs.—Pipe-flange bench near corner of St. Louis, Iron Mountain and Southern Railway section house at Gum Springs Station, Clark County, Ark. Bench is in line with west wall of main part of house, and also in line with south wall of "L". Elevation, 71.3821.

R. R. B. M. 7587.—A bench of the St. Louis, Iron Mountain and Southern Railway. Is a spike in eleventh telegraph pole south of milepost 411. Elevation, 61.0727.

P. B. M. Arkadelphia II.—Pipe-flange bench on pine knoll northwest of St. Louis, Iron Mountain and Southern depot at Arkadelphia, Clark County, Ark. Bench is 15 meters northeast of Maddox street and 40 meters from foot of hill, measured along street. Witnessed by three triangular blazed trees, as follows: 0.8-meter pine E. 2.2 meters; 0.7-meter pine SW. 2.1-meters, and 0.7 meter pine NW. 1.9 meters. Elevation, 72.0815.

P. B. M. Arkadelphia I.—Is a cross cut on top of section of iron rail at west corner of small inclosure immediately northeast of St. Louis, Iron Mountain and Southern depot at Arkadelphia, Clark County, Ark. Top of rail projects 0.1 meter above ground, and lower end is pierced by two bolts, which are embedded in cement. Elevation, 63.5883.

Gauge B. M. B. (*Evens*).—Is nail in running root of large gum, about 20 meters back of middle section of gauge and immediately below small ravine running past the section. The root has letter "B" marked on a small blaze and 0.2 meter back of bench. Elevation, 62.9349.

P. B. M. Ouachita River.—Is cross cut on top of pedestal stone at downstream end of pier and right bank end of St. Louis, Iron Mountain and Southern Railway bridge over Ouachita River at Arkadelphia, Clark County, Ark. Bench is 0.04 meter northwest of northwest edge of footplate of truss and 0.12 meter from northeast edge. Elevation, 65.5903.

P. B. M. Daleville.—Is at north corner of chimney at northwest side of office building of Arkadelphia Lumber Company at Daleville, Clark County, Ark., and is cross cut on second footing course from top at base of chimney. Building is 50 meters northeast of depot and 0.8 kilometer north of Ouachita River. Elevation, 63.1867.

P. B. M. Donaldson.—Is cross cut on top of section of iron rail near southeast corner of depot at Donaldson, Hot Spring County, Ark. Bench is in line with south wall of depot and 2.5 meters from east wall. Elevation, 75.8118.

P. B. M. Malvern.—Is bottom of square recess cut in north end of stone sill to door at southeast corner of roundhouse at Malvern, Hot Spring County, Ark. Roundhouse stands about 200 meters west of St. Louis, Iron Mountain and Southern Railway depot and 100 meters north of St. Louis, Iron Mountain and Southern track, and is the property of the Malvern and Hot Springs Railway. Marked $\overset{\text{U S}}{\underset{\text{B M}}{\square}}$ Elevation, 88.7035.

P. B. M. Traskwood.—Is cross cut on top of section of iron rail at northeast corner of wooded lot in front of G. W. Winter's hotel at Traskwood, Saline County, Ark. Bench is about 60 meters south of track and opposite west end of depot. Elevation, 95.1693.

P. B. M. Saline River.—Is cross cut on top of stone pedestal block at north end of west abutment of St. Louis, Iron Mountain and Southern Railway bridge over Saline River and in Saline County, Ark. Bench mark is 0.012 meter east of footplate of truss, in prolongation of south side. Elevation, 92.2498.

P. B. M. Benton.—Is cross cut on top of section of iron rail at northwest corner of small garden inclosure just east of depot at Benton, Saline County, Ark. Bench is 3 meters east of east wall of depot and 3 meters north of north wall. Elevation, 97.1382.

P. B. M. Alexander.—Is cross cut on top of section of iron rail at southest corner of small garden inclosure just west of depot at Alexander, Pulaski County, Ark. Bench is 3 meters west of west wall of depot and 2.5 meters south of south wall. Elevation, 105.6350.

P. B. M. Mablevale.—Is cross cut on top of iron casting at east side of inclosure around the public well at Mablevale, Pulaski County, Ark. It is 80 meters east of St. Louis, Iron Mountain and Southern Railway depot and 25 meters south of track. Witnessed by three triangular blazed trees, as follows: 0.3-meter sweet gum N. 2 meters, 0.4-meter black oak S. 2 meters, and 0.6-meter pine W. 8 meters. Elevation, 100.6988.

P. B. M. Ensign.—Is cross cut on top of iron rail at east fence of yard around section house at Ensign, Pulaski County, Ark. Is 10 meters east of east wall of house and in line with west wall. Elevation, 95.5912.

T. B. M. 11.—Nail in root of an oak 20 meters north of track and 30 meters west of railway section house at Ensign, Pulaski County, Ark. Elevation, 95.2697.

R. R. B. M. 14930.—Is spike in milepost 351. Elevation, 96.2656.

T. B. M. 4.—Is nail in root of a pine 50 meters north of track at west side of wagon road at first siding west of Little Rock, Pulaski County, Ark. Elevation, 100.0487.

T. B. M. 2.—Is head of railroad spike driven horizontally in retaining wall just north of St. Louis, Iron Mountain and Southern Railway depot at Little Rock, Pulaski County, Ark. Spike is at corner of wall adjoining depot, about 0.5 meter above railway platform and projects 0.02 meter from wall. Elevation, 86.3140.

C. and G. S. P. B. M. I. (*or 3*).—At Little Rock, Pulaski County, Ark. Is the bottom of a square cut in the stone door sill of the middle door, at the west end of it, of the brick building occupied by Whittemore & Gordon, pork brokers, at the foot of Commerce street, on the bank of the Arkansas River. C. and G. S. Survey elevation, 80.3434 meters, Gulf level. Elevation, 86.5377.

C. and G. S. P. B. M. O.—At Little Rock, Pulaski County, Ark. Bottom of a square cut in a 6-inch granite post set near the main entrance of the State capitol. This post is about 29½ inches south and about 33½ inches west of the southwest corner of the stone porch. C. and G. Survey elevation, 87.7888 meters, Gulf level. Elevation, 93.9820.

C. and G. S. P. B. M. A.—At Little Rock, Pulaski County, Ark. The center of cross in granite substructure of the east face of the United States customhouse and post-office. It is beneath the water-table course of masonry, and its center is about 13¾ inches north and about 5½ inches above the upper corner of the north line of the basement window nearest to Second street. C. and G. S. elevation, 91.0772 meters, Gulf level. Elevation, 97.2720.

C. and G. S. P. B. M. B.—At Little Rock, Pulaski County, Ark. Is rectangular cavity on the north side of the granite coping of wall inclosing the small sunken area immediately in front of basement window nearest to Second street in the United States customhouse and post-office building. C. and G. S. elevation, 90.6744 meters, Gulf level. Elevation, 96.8698.

B. M. Whittemore.—A bench of local engineers. Is top of water table at southeast corner of Whittemore and Gordon Building. It is 10 meters east of C. and G. S. P. B. M. I. (or 3). Elevation, 86.5257.

B. M. Abert.—A high-water mark of 1866. Is cross cut on northeast corner of Whittemore and Gordon Building, at Little Rock, Pulaski County, Ark., on east wall and 0.1 meter north of Merrill's gauge. Mark is 1.39 meters above projecting stone at bottom of wall used by Abert as a bench mark (1867). Elevation, 81.3234.

B. M. Merrill.—Was top of sill to window in east wall of basement of Whittemore and Gordon Building, foot of Commerce street, Little Rock, Pulaski County, Ark. Window was 3 meters from northeast corner of store. The window is now filled with stonework and the sill taken out. In connecting allowance was made for a 6-inch sill. The point used is not more than 0.1 meter in error. Elevation, 84.1598.

S. S. Gauge B. M.—Is the highest point of a 2-inch iron rod set solidly in the "Little Rock" about 30 meters east of south end of railroad bridge at Little Rock, Pulaski County, Ark. Rod is 2.5 meters south of S. S. inclined gauge. Elevation, 82.0229.

B. M. Statehouse steps.—On northwest corner of lowest step to middle south entrance to statehouse at Little Rock, Pulaski County, Ark. Elevation, 93.9643.

B. M. corner Main and Markham streets.—Is top of curbing at southwest corner of Main and Markham streets (probably disturbed). Elevation, 93.2540.

Gauge B. M. A. (*Evens*).—Is horizontal side of a triangle cut on west portion of upstream cylinder of first pier from right bank of Baring Cross Railway bridge. Is about 6 feet below second nut (from top of pier) on side of cylinder. Elevation, 79.9337.

B. M. I. (*Evens, 1887*).—Is top of third nut (counting down) on west part of upstream cylinder of first pier from right bank of Baring Cross Railway bridge. Is vertically under gauge B. M. A. Elevation, 78.1680.

No. 6 (*Gauge B. M.*).—Is bottom surface of iron cylinder cap of downstream cylinder of third pier from right bank of Baring Cross Railway bridge. Elevation, 86.2618.

MONROE TO MOUTH OF BLACK RIVER, LA.

P. B. M. 27.—See descriptions, Monroe, La., to Little Rock, Ark., p. 1468.

P. B. M. 28.—Pipestone bench in northwest corner of yard of T. C. McLain, West Monroe, Ouachita Parish, La., at southwest corner of Cotton and Natchitoches streets. Bench is 9.2 meters east of center line of McLain's house and 10 meters north of north face of brick chimney at east side of house. Elevation, 29.2147.

P. B. M. 26.—Is an arrow-cross (—+—→) cut in granite capstone of concrete pier, with sheet-iron casing, at north side of west pier of Vicksburg, Shreveport and Pacific Railway bridge over Ouachita River at Monroe, Ouachita Parish, La. Elevation, 30.8378.

P. B. M. 25.—See descriptions, Monroe, La., to Little Rock, Ark., p. 1468.

P. B. M. 24.—See descriptions, Monroe, La., to Little Rock, Ark., p. 1468.

B. M. C. (*Burrowes, 1883*).—Is on south side of stone cap of south tube in west abutment of railroad bridge at Monroe, Ouachita Parish, La. Point not marked. Burrowes's elevation, 50.169 feet. Elevation, 30.8355.

B. M. D. (*Burrowes, 1883*).—On north (or west?) side of stone cap of north tube of east abutment of railroad bridge at Monroe, Ouachita Parish, La. Point not marked. Elevation, 30.6821.

T. B. M. 102.—Is nail in root of 0.5-meter box elder, 13 meters from left bank of river, 7 meters from center of road, and 13 meters west of J. T. Mason's residence. Elevation, 29.6942.

T. B. M. 103.—Is nail in root of a 0.6-meter sycamore, 25 meters in front of Chaff plantation residence. Tree stands about 6 meters from wagon road on west side. Elevation, 30.5343.

T. B. M. 105.—Is nail in root of a 0.5-meter catalpa, 25 meters east from levee, 4 meters east from center of road, 350 meters southwest from railroad water tank, 60 meters northwest from old cabin, and 150 meters west of railroad. Elevation, 28.0010.

T. B. M. 110.—Is small boat spike in root of a 0.8-meter gum, 25 meters west from warehouse, which is 48 meters north of store at Logtown, Ouachita Parish, La. Tree stands on first bank on east side of river, 6 meters west of road, and has the letters "U S" cut on tree above bench. Elevation, 28.4133.

P. B. M. 9=P. R. P. Logtown.—Pipestone bench at Logtown, Ouachita Parish, La. Is in south corner of R. M. Filhiol's field, 23 meters from main bank and 70 meters from second bank of river, 16 meters west from west corner of store and 3 meters west of warehouse. Elevation, 27.8460.

T. B. M. 111.—Is small boat spike in root of a 0.8-meter mulberry, 9 meters east of east bank of river, 6 meters west of front fence of yard around residence of Joseph Bres, and 60 meters from southwest corner of residence. Elevation, 28.4346.

T. B. M. 113.—Is small boat spike in root of a 1-meter chinaberry, on edge of east bank of river, 6 meters west of center of road, 22 meters northwest of Charles Johnson's cabin, and 5 meters south of colored church. Elevation, 28.7429.

T. B. M. 114.—Is small boat spike in root of a 0.8-meter box elder, 126 meters southwest from Mrs. Faulk's residence. Tree is on first bank of river and 12 meters west of road. Elevation, 28.6288.

T. B. M. 119.—Is small boat spike in root of a 2-meter water oak, 19 meters south of Blankston P. O., Caldwell Parish, La., 29 meters southwest of warehouse and 6 meters north of levee. Elevation, 27.1546.

P. B. M. 10=P. R. P. Blankston.—Pipestone bench at Blankston, Caldwell Parish, La. Is at southwest corner of yard around I. A. Davis's residence, 1 meter from fence and 0.75 meter from post-office building, 38 meters from center of levee, and 75 meters from southwest corner of dwelling. Elevation, 25.7658.

T. B. M. 121.—Is a small boat spike in root of a 0.8-meter catalpa, 20 meters from east bank of river, 20 meters southeast of corner of cabin occupied by S. Y. Ellis, and 8 meters west from road. Elevation, 28.1488.

B. M. 30 B (1873).—On catalpa, 24 inches diameter, in front of house at Sinope Landing, Caldwell Parish, La. It is 20 meters from bank of river. Elevation, 28.4700.

T. B. M. 125.—Is cross cut on top of marble stone, 0.12 meter square, on dividing line between Call and Faulkner places. It is 5 meters south of road, 100 meters from left bank of river, and 130 meters southwest from Orange Call's dwelling. Elevation, 27.7891.

T. B. M. 127.—Is small boat spike in root of a 1 meter sweet gum, 36 meters southwest from center line of road, 10 meters east from railroad, and 100 meters southeast from southeast corner of Riverton Station, Caldwell Parish, La. Elevation, 26.6982.

T. B. M. 128.—Is small boat spike in root of a 0.5 meter elm, 10 meters east from center of railroad track, 25 meters west from vacant cabin, 150 meters north from north end of trestle, and 50 meters east from east bank of Smith Lake, Caldwell Parish, La. Tree has the letters U S cut on it above bench. Elevation, 26.6812.

P. B. M. 11.—Pipestone bench about 1,750 meters below Riverton Station, Caldwell Parish, La. It is 22 meters from center of railroad, 50 meters from Smith Lake, 300 meters from end of trestle approach to drawbridge, and 23 meters from corner of old cabin in field belonging to Mrs. Ruttland. Elevation, 25.4271.

Railway B. M.—Is nail in root of a 0.4-meter mulberry, 30 meters from railroad track, and 60 meters from Smith Lake, Caldwell Parish, La. It is near abandoned cabin on Mrs. Ruttland's place and about 250 meters from end of trestle approach to drawbridge over Ouachita River. The figures 72.16 were found written above bench on tree. Elevation, 26.5186.

Gauge B. M. B.—Is a cross cut on top of lower of first two piers from Riverton shore. Is on east side of east pier of north end of drawbridge over Ouachita River. Elevation, 29.5912.

T. B. M. 128A.—Is a small boat spike in root of a 0.5-meter water oak, 70 meters north from left bank of river, 40 meters west from center line of trestle, and 100 meters northwest from north end of north span of bridge. Elevation, 25.1080.

Gauge B. M. A.—Is chisel mark cut in upper edge of lowest piece of sheet-iron casing of west pier at north end of drawbridge across Ouachita River, near Riverton, Caldwell Parish, La. Elevation, 23.3299.

T. B. M. 131.—Is small boat spike in root of a 1.5-meter water oak, which is in middle of cluster of trees on bank of Horseshoe Lake, Caldwell Parish, La., 5 meters from center line of road, 40 meters northwest of N. M. Davis's dwelling, and 30 meters north of blacksmith shop which stands on bank of lake. Elevation, 26.5258.

T. B. M. 133.—Is small boat spike in root of a 0.8-meter sweet gum on north edge of road, 40 meters east from left bank of Ouachita River, 33 meters from center of crossroad and 75 meters southeast from Jacks Landing, Caldwell Parish, La. Elevation, 26.1923.

T. B. M. 133a.—Is small boat spike in root of 1-meter water oak, opposite Columbia, Caldwell Parish, La., 28 meters back from river bank, 13 meters south of center of road, and 75 meters northwest from ferry landing. Elevation, 25.6899.

P. B. M. 12.—Pipestone bench at Columbia, Caldwell Parish, La. Is in northwest corner of courthouse yard, at corner of Wall and Main streets. It is 32 meters from northwest corner of "jury room." Elevation, 24.8784.

T. B. M. 134.—Probably disturbed.

T. B. M. 135.—Is iron bolt in root of a 1-meter pecan, 95 meters north of Bellevue Landing, Caldwell Parish, La., 3 meters east from center of road, and 74 meters west from Dick Dawfelt's dwelling. Elevation, 26.0753.

T. B. M. 137.—Is small-boat spike in root of a 1-meter elm, 800 meters east from left bank of river, 150 meters east from west edge of woods, 800 meters from Henrietta Landing, Caldwell Parish, La. Tree stands on south side of road to Harrisonburg and has the letters U S cut on it above bench. Elevation, 24.3640.

T. B. M. 138.—Is small boat spike in root of a 0.15-meter red oak, 4 meters east of road, 170 meters south from edge of woods. The tree has the letters U S cut on it above bench. Elevation, 25.2298.

T. B. M. 140.—Is small boat spike in root of a 1-meter sweet gum, 76 meters east from southeast corner of James's place, 100 meters from left bank of river, 10 meters north of road. The letters U S are cut on tree above bench. Elevation, 25.1361.

T. B. M. 141.—Is small boat spike in root of a 1-meter elm, 4 meters east of road, on edge of bank of Long Lake, 70 meters southeast from cabin on Hays's place. The letters U S are cut on tree above bench. Elevation, 25.0499.

T. B. M. 142.—Is small boat spike in root of a 1-meter oak stump on east bank of Long Lake, on west edge of road, 25 meters northwest from corner of cabin which is on Ruttland place. Elevation, 25.5243.

P. R. P. Gibson.—Pipe-flange bench at Gibsons Landing, Caldwell Parish, La. Is in northwest corner of J. W. Price's yard, on west bank of Ouachita River, 10 meters north of north wall of house and 5 meters west of west wall. Reference tree is 0.9-meter elm 3 meters east of bench. Elevation, 24.8514.

T. B. M. 143.—Is small boat spike in root of a 1.2-meter red oak 15 meters east of left bank of river, 25 meters west of road, 150 meters south of Long Lake, and 100 meters south of Long Lake Landing, Caldwell Parish, La. The tree has the letters U S cut on it above bench. Elevation, 24.8769.

P. B. M. 13=P. R. P. King.—Pipestone bench at Coles Landing, Caldwell Parish, La. It is in southwest corner of field belonging to V. Thompson. Is 16 meters east of Wade Bayou, 20 meters north of east bank of river, and 4 meters east of road. Elevation, 24.6425.

T. B. M. 149.—Is small boat spike in root of a 1.3-meter pin oak, 6 meters west from fence on west side of C. C. Myer's place, 20 meters east from road, and 800 meters south from dwelling. The letters U S are cut on tree above bench. Elevation, 24.4983.

T. B. M. 151.—Is 10d nail in root of a 1.5-meter pin oak, 25 meters east from left bank of river, on left side of road and 20 meters northeast of Indian mound on left bank of river. Elevation, 24.9027.

P. B. M. 14=P. R. P. Cottingham.—Pipestone bench at Cottingham Landing, Caldwell Parish, La. It is 300 meters northwest of east bank of river and 22 meters west of road. It is on top of ridge and 8 meters from sloping bank leading into adjacent swamp. Elevation, 23.8174.

T. B. M. 62.—Is nail in root of a 1-meter water oak, 116 meters north of Bayou Dan and 100 meters west of river. Tree has the letters U S cut on it above bench. Elevation, 23.5726.

B. M. B.—At Danville, Caldwell Parish, La. Is top of gas pipe driven in ground in northwest corner of horse lot adjoining Baughman's residence, 80 meters west of right bank of river and 85 meters south of right bank of Bayou Dan. Elevation, 24.5363.

T. B. M. 61.—Is nail in root of a 0.5-meter pecan, 90 meters north of Baughman's residence, 60 meters from right bank of river, and 20 meters south of right bank of Bayou Dan. Elevation, 23.9722.

T. B. M. 58.—Is nail in root of sweet gum on edge of north bank of Peters Bayou and about 300 meters from mouth of bayou. Elevation, 23.4058.

B. M. A.—Is on property of P. H. Carter, between H. T. Young and sawmill landings. Is about 100 meters from bank of river and 2.3 meters inside of field from fence. Elevation, 24.4474.

T. B. M. 54.—Is nail in root of 1.2-meter white oak, 20 meters west of bank of Big Lake, Caldwell Parish, La., and 130 meters south of Indian mound. Tree has the letters U S cut on it above bench. Elevation, 25.1563.

P. B. M. 8=P. R. P. Stafford.—At Stafford, Catahoula Parish, La. Is top of head of copper bolt leaded in stone 56 by 40 centimeters, with usual pipe on top. Is 70 meters west of west bank of river, 30 meters southwest of southwest corner of Stafford's house, and opposite mouth of Bœuf River. Elevation, 23.3622.

T. B. M. 49.—Is nail in root of a 1-meter elm, 25 meters east of Stafford's residence and 8 meters west of west bank of river. Elevation, 23.9505.

B. M. 39 B. (1873).—Was in elm opposite store at mouth of Bœuf River near Stafford's house. Tree has caved into river, but root taken was root to original tree and will not vary 6 inches from height of bench. Elevation, 23.7725.

P. B. M. 7=P. R. P. Catahoula.—Pipestone bench at Catahoula Shoals, Catahoula Parish, La. Is 12 meters back from west bank of river in grove of small pines, and 25 meters from remains of old cabin in abandoned field. Elevation, 23.6142.

T. B. M. H.—Is cross cut in top of northeast corner of stone 0.8 by 0.4 by 0.8 meter on west bank of river, 7 meters northeast from corner of fence, in front of Harrisonburg, Catahoula Parish, La. Elevation, 24.5612.

B. M. V. (1858).—At Harrisonburg, Catahoula Parish, La. Is a bench of the Delta survey. Is a V mark on first brick above projecting course of brick almost level with surface of ground on east face of northeast corner of clerk's office in courthouse yard. Delta survey elevation, 157.50 feet. Elevation, 26.7185.

P. B. M. 6.—At Harrisonburg, Catahoula Parish, La. Is center of cross cut on head of copper bolt leaded in upper edge of second course of brick, 14 centimeters above stone foundation on west side and 34 centimeters from southwest corner of Catahoula Parish jail. Is on second brick from corner, and the letters U S cut in brick. Elevation, 30.2843.

T. B. M. 40.—Is nail in root of a 1-meter pecan in back yard of Mrs. H. A. Segrist's property in Harrisonburg, Catahoula Parish, La. Elevation, 28.6312.

T. B. M. 38.—Is nail in root of a 1.4-meter live oak on edge of road, 30 meters southeast from Hugh's dwelling and 40 meters north of Bushley Bayou. Elevation, 24.4086.

T. B. M. 34.—Is nail in root of a 0.3-meter black locust, 7 meters west of road on Clew place and 400 meters southeast from dwelling on Kirby's place. Elevation, 24.6907.

T. B. M. 29.—Is nail in root of pecan, 71 meters northwest of river and 35 meters southwest of Mrs. Calvert's residence on Gillespie place. Elevation, 23.8614.

P. B. M. 5.—Pipestone bench at Trinity, Catahoula Parish, La. Is on property of Guss estate, immediately back of kitchen back of house, 0.6 meter from west fence and 10 meters from south fence. Elevation, 22.5261.

T. B. M. 28.—Is nail in root of honey locust 18 meters north of Crook's store on the bank at the mouth of Little River, and 15 meters south of the Guss residence in Trinity, Catahoula Parish, La. Elevation, 22.6147.

P. B. M. 4.—Pipestone bench at Jonesville, Catahoula Parish, La. Is in northeast corner of lot of Dr. Baker and adjoining his drug store, and 23 meters from corner of streets. Elevation, 22.6462.

T. B. M. 27.—Is nail in root of pecan, 41 meters from track, on bank of Black River, and 30 meters northeast from northeast corner of station platform. Elevation, 22.6883.

P. B. M. 3.—Pipestone bench at Black River Station, Concordia Parish, La. Is 35 meters east of left bank of Black River, opposite mouth of Little River, 25 meters from railway track and 65 meters from depot platform. Elevation, 21.7867.

T. B. M. 1.—Is spike in root of 1.5-meter oak, 16 meters east of levee on east side of Boatner place, 8 meters east of road, 200 meters west of west bank of Black River, and 200 meters northeast from plantation residence. The letters U. S. are cut on tree above bench. Elevation, 22.8679.

T. B. M. 2.—Is spike in root of a 1.5-meter oak on east edge of road, 8 meters east of levee, 150 meters west from west bank of river, 247 meters south from old store, which is 10 meters west from levee and 1 kilometer below Boatner's plantation store. Elevation, 23.1997.

T. B. M. 3.—Is spike in root of a 0.5-meter pecan, 15 meters west of levee, 100 meters southwest from Mays Landing, 75 meters west from river, and 100 meters southwest from agent's house on Spencer's place. Elevation, 23.2360.

T. B. M. 4.—Is a spike in root of a 1-meter sycamore, 8 meters west from river, on top of levee, 8 meters east of road, 100 meters northeast from Nathan Calhoun's residence, and 150 meters south from Gibbs Bayou. Elevation, 23.8268.

P. B. M. 5a=P. R. P. Jones.—Pipe-flange bench at head of Jones Bayou, Catahoula Parish, La. Is on south bank of Jones Bayou and east side of public road on Nicholia place. Elevation, 24.1413.

T. B. M. 6.—Is spike in root of a 1-meter sycamore, 20 meters west from west bank of river, 100 meters above opening leading to Mrs. Gaynor's residence on east bank of river, and 200 meters north of Dr. May's residence. Elevation, 23.7100.

T. B. M. 133a.—Is small boat spike in root of 1-meter water oak, opposite Columbia, Caldwell Parish, La., 28 meters back from river bank, 13 meters south of center of road, and 75 meters northwest from ferry landing. Elevation, 25.6899.

P. B. M. 12.—Pipestone bench at Columbia, Caldwell Parish, La. Is in northwest corner of courthouse yard, at corner of Wall and Main streets. It is 32 meters from northwest corner of "jury room." Elevation, 24.8784.

T. B. M. 134.—Probably disturbed.

T. B. M. 135.—Is iron bolt in root of a 1-meter pecan, 95 meters north of Bellevue Landing, Caldwell Parish, La., 3 meters east from center of road, and 74 meters west from Dick Dawfelt's dwelling. Elevation, 26.0753.

T. B. M. 137.—Is small-boat spike in root of a 1-meter elm, 800 meters east from left bank of river, 150 meters east from west edge of woods, 800 meters from Henrietta Landing, Caldwell Parish, La. Tree stands on south side of road to Harrisonburg and has the letters U S cut on it above bench. Elevation, 24.3640.

T. B. M. 138.—Is small boat spike in root of a 0.15-meter red oak, 4 meters east of road, 170 meters south from edge of woods. The tree has the letters U S cut on it above bench. Elevation, 25.2298.

T. B. M. 140.—Is small boat spike in root of a 1-meter sweet gum, 76 meters east from southeast corner of James's place, 100 meters from left bank of river, 10 meters north of road. The letters U S are cut on tree above bench. Elevation, 25.1361.

T. B. M. 141.—Is small boat spike in root of a 1-meter elm, 4 meters east of road, on edge of bank of Long Lake, 70 meters southeast from cabin on Hays's place. The letters U S are cut on tree above bench. Elevation, 25.0499.

T. B. M. 142.—Is small boat spike in root of a 1-meter oak stump on east bank of Long Lake, on west edge of road, 25 meters northwest from corner of cabin which is on Ruttland place. Elevation, 25.5243.

P. R. P. Gibson.—Pipe-flange bench at Gibsons Landing, Caldwell Parish, La. Is in northwest corner of J. W. Price's yard, on west bank of Ouachita River, 10 meters north of north wall of house and 5 meters west of west wall. Reference tree is 0.9-meter elm 3 meters east of bench. Elevation, 24.8514.

T. B. M. 143.—Is small boat spike in root of a 1.2-meter red oak 15 meters east of left bank of river, 25 meters west of road, 150 meters south of Long Lake, and 100 meters south of Long Lake Landing, Caldwell Parish, La. The tree has the letters U S cut on it above bench. Elevation, 24.8769.

P. B. M. 13=P. R. P. King.—Pipestone bench at Coles Landing, Caldwell Parish, La. It is in southwest corner of field belonging to V. Thompson. Is 16 meters east of Wade Bayou, 20 meters north of east bank of river, and 4 meters east of road. Elevation, 24.6425.

T. B. M. 149.—Is small boat spike in root of a 1.3-meter pin oak, 6 meters west from fence on west side of C. C. Myer's place, 20 meters east from road, and 800 meters south from dwelling. The letters U S are cut on tree above bench. Elevation, 24.4983.

T. B. M. 151.—Is 10d nail in root of a 1.5-meter pin oak, 25 meters east from left bank of river, on left side of road and 20 meters northeast of Indian mound on left bank of river. Elevation, 24.9027.

P. B. M. 14=P. R. P. Cottingham.—Pipestone bench at Cottingham Landing, Caldwell Parish, La. It is 300 meters northwest of east bank of river and 22 meters west of road. It is on top of ridge and 8 meters from sloping bank leading into adjacent swamp. Elevation, 23.8174.

T. B. M. 62.—Is nail in root of a 1-meter water oak, 116 meters north of Bayou Dan and 100 meters west of river. Tree has the letters U S cut on it above bench. Elevation, 23.5726.

B. M. B.—At Danville, Caldwell Parish, La. Is top of gas pipe driven in ground in northwest corner of horse lot adjoining Baughman's residence, 80 meters west of right bank of river and 85 meters south of right bank of Bayou Dan. Elevation, 24.5363.

T. B. M. 61.—Is nail in root of a 0.5-meter pecan, 90 meters north of Baughman's residence, 60 meters from right bank of river, and 20 meters south of right bank of Bayou Dan. Elevation, 23.9722.

T. B. M. 58.—Is nail in root of sweet gum on edge of north bank of Peters Bayou and about 300 meters from mouth of bayou. Elevation, 23.4058.

B. M. A.—Is on property of P. H. Carter, between H. T. Young and sawmill landings. Is about 100 meters from bank of river and 2.3 meters inside of field from fence. Elevation, 24.4474.

T. B. M. 54.—Is nail in root of 1.2-meter white oak, 20 meters west of bank of Big Lake, Caldwell Parish, La., and 130 meters south of Indian mound. Tree has the letters U S cut on it above bench. Elevation, 25.1563.

P. B. M. 8=P. R. P. Stafford.—At Stafford, Catahoula Parish, La. Is top of head of

CAMDEN, ARK., TO SHREVEPORT, LA.

P. B. M. Camden IV.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1471).

P. R. P. Camdem III.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1472).

T. B. M. 201.—Is boat spike in root of a 0.2-meter pine, 10 meters west of St. Louis Southwestern Railway track on a line passing 20 meters south of south end of depot at Camden, Ouachita County, Ark. The letters U S are cut on tree above bench. Elevation, 48.2347.

T. B. M. 202.—Boat spike in root of a 0.2-meter sweet gum, 17 meters east of track, 20 meters south of sign marking south limit of railway yard at Camden, Ark. The letters U S are cut on tree above bench. Elevation, 45.9476.

T. B. M. 203.—Boat spike in root of a 0.2-meter sweet gum, 13 meters east of track, 60 meters south of south end of trestle over "Two Bayou." Elevation, 39.3401.

T. B. M. 204.—A Geological Survey bench. Is a small wire nail in root of a 0.3-meter black gum, 25 meters east of track, 20 meters north of where track enters first cut south of "Two Bayou." A blaze on tree has the figures 122 painted on it. Geological Survey elevation, 121.987+0.959 feet, Gulf level. Elevation, 43.3623.

T. B. M. 205.—A Geological Survey bench. Is a small wire nail in root of a 0.3-meter white oak, 15 meters east of track, 35 meters south of trestle 832. A blaze on tree has the figures 125 painted on it. Geological Survey elevation, 124.945+0.959 feet, Gulf level. Elevation, 44.2609.

T. B. M. 206.—A Geological Survey bench. Is a small wire nail in root of a 0.1-meter red oak near foot of long grade, 20 meters north of track at a point where wagon road crosses same. A blaze on tree has the figures 170 painted on it. Geological Survey elevation, 170.214+0.959 feet, Gulf level. Elevation, 58.0734.

T. B. M. 207.—A Geological Survey bench. Is a small wire nail in root of a 0.3-meter water oak, 15 meters east of main track at Finn Station, 90 meters from point where siding leaves track and 50 meters north of store. A blaze on tree has the figures 142 painted on it. Geological Survey elevation, 142.374+0.959 feet, Gulf level. Elevation, 49.5756.

T. B. M. 208.—Boat spike in root of a 0.2-meter sweet gum, 15 meters east of track, 65 meters south of milepost 345, and 10 meters south of trestle 843, 1.4 kilometers south of Finn Station. The tree has the letters " U S" cut on it above bench. Elevation, 51.7117.

T. B. M. 209.—A Geological Survey bench. Is a small wire nail in root of a 0.4-meter red oak, 20 meters east of track and 800 meters north of water tank, 60 meters north of the switch at Moro Spur. A blaze on tree has the figures 186 painted on it. Geological Survey elevation, 186.714+0.959 feet, Gulf level. Elevation, 63.0933.

T. B. M. 210.—A Geological Survey bench. Is a small wire nail in the root of a 0.4-meter pine, 15 meters west of track, and about 800 meters south of water tank. A blaze on tree has the figures 229 painted on it. Geological Survey elevation, 229.733+0.959 feet, Gulf level. Elevation, 76.2210.

U. S. Geological B. M.—Is a standard bench of the Geological Survey at Buena Vista, Ouachita County, Ark. Is 35 meters west of the northwest corner of depot, and in corner formed by post-office building and fence around adjoining yard. Geological Survey elevation, 287.540+0.959 feet, Gulf level. Elevation, 93.8461.

P. B. M. Buena Vista.—Pipestone bench at Buena Vista, Ouachita County, Ark. It is 9 meters west of main track and 110 meters south of southeast corner of depot. Elevation, 92.1973.

T. B. M. 211.—Boat spike in root of a 0.4-meter sweet gum on F. M. Cross's place, about 150 meters from house and 15 meters north of track. The letters U S are cut on tree above bench. Elevation, 95.5267.

T. B. M. 212.—Boat spike in root of a 0.5-meter sweet gum 20 meters northeast of track, 30 meters southwest of vacant cabin, and 370 meters north of Jones and Frisby's mill. The letters U S are cut on tree above bench. Elevation, 90.6602.

T. B. M. 213.—Boat spike in root of a 0.3-meter white oak 20 meters north of track and about 500 meters below milepost 352, 6 telegraph poles north of wagon-road crossing. The letters U S are cut on tree above bench. Elevation, 77.0493.

T. B. M. 214.—Boat spike in root of a 0.4-meter sweet gum 20 meters west of track, 130 meters south of trestle 853, and about 1 kilometer below Ogamaw, Ouachita County, Ark. The tree has the letters U S cut on it above bench. Elevation, 63.4957.

R. R. B. M.—On same tree as T. B. M. 214, and described as follows: "Spike in gum tree 50′ right, about 400 feet south of trestle 853; elevation, 186.25." Elevation, 63.7500.

T. B. M. 217.—Boat spike in root of a 0.4-meter pine 20 meters west of track, in front of and 20 meters from gin, and 100 meters north of depot at Stephens, Ark. Elevation, 77.3933.

P. B. M. Stephens.—Pipestone bench at Stephens, Ouachita County, Ark. In northeast corner of yard to hotel belonging to Mrs. S. Boggs, 25 meters west of St. Louis South-Western Railway track, 25 meters from corner of hotel, 24 meters from corner of gin, and 78 meters from corner of depot. Elevation, 78.0114.

T. B. M. 218.—Boat spike in root of a 0.4-meter holly 15 meters from left bank of Smackover Creek, 20 meters south of track, on a line even with beginning of trestle over creek. The letters U S are cut on tree above bench. Elevation, 61.8138.

R. R. B. M.—On same tree as T. B. M. 218, and is described as follows: "Spike in holly about 60 feet from left bank of Smackover Creek; elevation, 180.13." Elevation, 62.3137.

T. B. M. 219.—Boat spike in root of a 0.4-meter water oak, 20 meters northeast of track, 40 meters south of milepost 461. The letters U S are cut on tree above bench. Elevation, 65.2420.

T. B. M. 220.—Boat spike in root of a 0.3-meter oak, 15 meters southeast of track at north end of trestle 885, and about 700 meters north of Milner, Ark. The letters U S are cut on tree above bench. Elevation, 70.6842.

T. B. M. 221.—Boat spike in root of a 0.3-meter maple, 20 meters southwest of main track, 200 meters north of railway platform at Milner, Ark. Elevation, 72.9913.

T. B. M. 222.—Boat spike in root of a 0.6-meter black gum, about 50 meters south of track, at a point where the Spring Hill wagon road crosses same and about 400 meters west of water tank. Elevation, 82.8583.

T. B. M. 223.—Boat spike in root of a 0.3-meter red oak, 17 meters northeast of first cut southwest of Magnesia Springs and at beginning of curve in railway track. The letters U S are cut on tree above bench. Elevation, 98.6324.

T. B. M. 224.—Boat spike in root of a 0.4-meter sweet gum, about 45 meters south of main track and opposite section house of the St. Louis Southwestern Railway, and 150 meters west of depot at McNeil, Ark. Elevation, 104.9734.

P. B. M. McNeil.—Pipestone bench at McNeil, Columbia County, Ark. On east side of cattle pen at the northeast corner, 28 meters south from the main track of the St. Louis Southwestern Railway, 11½ meters from the corner of transfer shed, and about 170 meters from depot. Elevation, 104.4198.

T. B. M. 225.—Boat spike in root of a 4-pronged sweet gum, on bank of small drain, 6 telegraph poles west of milepost 370 and 15 meters south of track. The letters U S are cut on tree above bench. Elevation, 97.1807.

T. B. M. 226.—Boat spike in root of a 0.3-meter red oak, opposite site of old sawmill, 10 meters from abandoned store in cotton field. Elevation, 100.2340.

T. B. M. 227.—Boat spike in root of a 0.6-meter post oak, 30 meters south of track and 3½ telegraph poles west of milepost 373. The letters U S are cut on tree above bench. Elevation, 114.3512.

P. B. M. Waldo.—Pipestone bench at Waldo, Columbia County, Ark. At south edge of the St. Louis Southwestern Railway right of way, 48 meters from track, 60 meters from switch at end of siding, and 270 meters east from depot. Elevation, 113.4801.

T. B. M. 229.—Boat spike in root of a 0.4-meter white oak, 15 meters north of track, 500 meters west of milepost 376. The letters U S are cut on tree above bench. Elevation, 98.8624.

R. R. B. M.—Is on same tree as T. B. M. 229. Elevation, 99.0034.

T. B. M. 231.—Boat spike in root of a 0.4-meter pine, 20 meters south of track at a point where the Buckner wagon road crosses same, 3½ telegraph poles west of milepost 379. The letters U S are cut on tree above bench. Elevation, 90.4892.

T. B. M. 232.—Boat spike in root of a 0.3-meter water oak, 25 meters north of track, 90 meters west of trestle over Bayou D'Orcheat, 70 meters west of sign reading "Station, 1 mile." (Referring to Buckner.) The letters U S are cut on tree above bench. Elevation, 80.9950.

R. R. B. M.—A railroad spike in a 0.4-meter post oak, 20 meters south of track at a point 40 meters west of T. B. M. 232. Elevation, 81.6319.

T. B. M. 234.—Boat spike in root of a 0.2-meter hickory, 20 meters north of track at beginning of cut where road makes a sharp curve to south. Elevation, 92.2844.

P. B. M. Stamp.—Pipe-stone bench at Stamps, Lafayette County, Ark. It is in the northeast corner of lot inclosing offices and buildings of the Louisiana and Arkansas Railroad, 38 meters north of main track of the St. Louis Southwestern Railway and about 50 meters from depot. Elevation, 87.6239.

T. B. M. 236.—Boat spike in root of a 0.4-meter post oak, 25 meters north of track, 40 meters east of milepost 386. The letters U S are cut on tree above bench. Elevation, 84.0263.

T. B. M. 237.—Boat spike in root of a 0.2-meter pine, 20 meters north of track, 10 meters west of milepost 388. At east end of first cut east of Lewisville, Ark. The letters U S are cut on tree above bench. Elevation, 91.0887.

T. B. M. 238.—Boat spike in root of a 2-pronged red oak, 40 meters south of track at a point 90 meters west of depot at Lewisville, Ark. The letters U S are cut on tree above bench. Elevation, 86.2838.

P. B. M. Lewisville.—Pipestone bench at New Lewisville, Lafayette County, Ark. At east corner of cattle pen, 28 meters east of main track of St. Louis Southwestern Railway, 90 meters southwest from depot. Elevation, 85.3837.

T. B. M. 239.—Is X chiseled on head of boiler rivet holding two sheets of sheet iron resting on stone foundation pier for water tank at junction of Shreveport branch with main line of St. Louis Southwestern Railway. Bench is on pier next to main track and toward Lewisville and on the southwest corner of sheet-iron plate. Elevation, 89.9405.

T. B. M. 239 B.—Boat spike in root of a 0.3-meter ash (or linn?), 25 meters north of track, 12 telegraph poles west of milepost 393, and 350 meters west of trestle 959a. The letters U S are cut on tree above bench. Elevation, 74.8010.

Gauge B. M. A. (*Ewens*).—Is railroad spike in root of a 0.6-meter hackberry, 80 meters upstream from north end of railway bridge over Red River at Garland, Ark. Bench is on the river side of tree. Elevation, 76.2415.

P. B. M. Garland.—Pipestone bench at Garland, Miller County, Ark., on right bank of Red River, 100 meters northwest of pier approach to railway drawbridge, 24 meters west of main track and about 500 meters south of depot. Elevation, 76.7122.

B. M. 4. (*Red River survey*).—Pipestone bench at Garland, Miller County, Ark., at northwest corner of St. Louis Southwestern Railway section house. It is 2,020 feet from center pier of railway drawbridge and 70 feet north of track. St. Louis Southwestern Railway elevation, 230.50 feet. Elevation, 76.4995.

T. B. M. 240.—Boat spike in root of a 0.5-meter red oak, 15 meters west of track, 1.6 kilometers south of junction of Shreveport branch with the main line of the St. Louis Southwestern Railway. The letters U S are cut on tree above bench. Elevation, 87.9127.

T. B. M. 241.—Nail in root of a 0.15-meter red oak, 15 meters east of track, 30 meters north of trestle 2. The letters U S are cut on tree above bench. Elevation, 88.3969.

T. B. M. 242.—Boat spike in root of a 0.3-meter white oak, 20 meters east of track, 70 meters south of railway platform at Kress City. The letters U S are cut on tree above bench. Elevation, 87.7782.

T. B. M. 243.—Boat spike in root of a 0.3-meter post oak, 30 meters east of track, 4 telegraph poles north of milepost 396. The letters U S are cut on tree above bench. Elevation, 83.0174.

T. B. M. 244.—Boat spike in root of a 0.2-meter black-jack oak, 20 meters west of track, 200 meters north of section house, 7 telegraph poles north of milepost 398. The letters U S are cut on tree above bench. Elevation, 80.2228.

T. B. M. 245.—Boat spike in root of a 0.5-meter red oak, 25 meters east of track, 500 meters south of milepost 399. The letters U S are cut on tree above bench. Elevation, 84.8384.

T. B. M. 246.—Boat spike in root of a 0.4-meter post oak, 30 meters west of track, 11 telegraph poles north of milepost 401. The letters U S are cut on tree above bench. Elevation, 85.7119.

T. B. M. 247.—Boat spike in root of a 0.8-meter post oak, 25 meters east of track, 1½ telegraph poles south of trestle 10. The letters U S are cut on tree above bench. Elevation, 85.2129.

T. B. M. 248.—Boat spike in root of a 0.5-meter pin oak, 30 meters west of track, 50 meters north of depot at Canfield, Ark. The letters U S are cut on tree above bench. Elevation, 85.8407.

T. B. M. 248B.—Boat spike in root of a 0.8-meter cottonwood, 1 meter west of road where the Jordan Ferry road leaves main public road. The letters U S are cut on tree above bench. Elevation, 81.6366.

T. B. M. 248C.—Boat spike in root of a 0.6-meter white oak, at edge of the Jordan Ferry road. The letters U S are cut on tree above bench. Elevation, 86.7512.

T. B. M. 248 D.—Boat spike in root of a 0.4-meter post oak at edge of Jordan Ferry road, and 600 meters east of where road descends hill into swamp. Elevation, 87.3243.

T. B. M. 248 E.—Boat spike in root of a 1-meter cow oak, on bank of lake, 1 meter west of road, 230 meters west of bridge over slough. The letters U S are cut on tree above bench. Elevation, 72.3179.

T. B. M. 248 F.—Boat spike in root of a 0.6-meter dead cottonwood on bank of outlet to Red Lake, 1 meter north of Jordan Ferry road, 200 meters south of ferry, and 30 meters southeast of cabin on Ward place, 150 meters southeast of residence of Tom Ward. Elevation, 72.7153.

P. B. M. Jordan.—Pipestone bench about 150 meters east of left bank of Red River at Jordan Ferry, Lafayette County, Ark., at edge of road 3 meters south of Terrell Bayou and on Ward place. Elevation, 71.8754.

P. R. P. 14 (*Red River survey*).—Pipestone bench on left bank of Red River about 800 feet back of Jordan Landing, Lafayette County, Ark., and 500 feet south of Terrell Bayou at angle in levee between the Terrell and Dixon plantations. Elevation, 71.9676.

P. B. M. Canfield.—Pipestone bench at Canfield, Lafayette County, Ark. Is 2.7 meters from southwest corner of cattle pen, 19 meters west of main track, and 95 meters northwest of corner of depot of the St. Louis Southwestern Railway. Elevation, 85.0134.

T. B. M. 249.—Boat spike in root of a 0.6-meter red oak 20 meters east of track, 16½ telegraph poles north of milepost 405. Elevation, 84.6023.

T..B. M. 250.—Boat spike in root of a 0.3-meter white oak 30 meters west of track, about halfway between mileposts 406 and 407. The letters "U S" are cut on tree above bench. Elevation, 82.1219.

T. B. M. 251.—Boat spike in root of a 0.4-meter sweet gum 25 meters west of track, and 50 meters north of depot at Bradley, Ark. Elevation, 83.5272.

P. B. M. Bradley.—Pipestone bench at Bradley, Lafayette County, Ark., at northwest corner of depot, 13 meters west of main track of the St. Louis Southwestern Railway. Elevation, 83.1348.

T. B. M. 252.—Boat spike in root of a 0.5-meter post oak 25 meters east of track, 20 meters east of signboard reading "Station 1 mile." Elevation, 83.0615.

T. B. M. 253.—Boat spike in root of a 0.5-meter post oak, 30 meters east of track at a point where wagon road crosses same, 3½ telegraph poles north of milepost 411, and 500 meters north of tank. Elevation, 83.2951.

T. B. M. 254.—Boat spike in root of a 0.5-meter post oak, 20 meters west of track, 500 meters south of milepost 412, 30 meters south of trestle 20. The letters "U S" are cut on tree above bench. Elevation, 81.0668.

T. B. M. 255.—Boat spike in root of a 0.2-meter red oak, 25 meters east of track, 1 telegraph pole south of milepost 414, and 1 telegraph pole north of Louisiana and Arkansas State line. The letters "U S" are cut on tree above bench. Elevation, 81.0209.

T. B. M. 256.—Boat spike in root of a 0.3-meter pine, 15 meters east of track at point of curvature of first curve south of Arkanna. The letters "U S" are cut on tree above bench. Elevation, 80.5860.

T. B. M. 257.—Boat spike in root of a 0.4-meter red oak, 20 meters west of track, 8 telegraph poles north of first cattle-gap south of Arkanna. The letters "U S" are cut on tree above bench. Elevation, 81.9368.

T. B. M. 258.—Boat spike in root of a 0.3-meter red oak, 15 meters west of track, 30 meters south of wagon road crossing at Roberta post-office. The letters "U S" are cut on tree above bench. Elevation, 103.9753.

T. B. M. 259.—Boat spike in root of a 0.6-meter white oak, 25 meters east of track, 8 telegraph poles north of milepost 419. The letters "U S" are cut on tree above bench. Elevation, 109.6634.

T. B. M. 260.—Boat spike in root of a 0.2-meter post oak, 25 meters east of track at the north end of first cut north of Plain Dealing and also the first cut south of Bolinger. The letters "U S" are cut on tree above bench. Elevation, 107.3809.

T. B. M. 261.—Boat spike in root of a 0.3-meter cottonwood, 25 meters west of track, 3½ telegraph poles south of milepost 422, and 80 meters north of depot at Plain Dealing. The letters "U S" are cut on tree above bench. Elevation, 86.4156.

T. B. M. 261 A.— Boat spike in root of a 0.6-meter red oak, 5 meters northeast of road from Plain Dealing to Millers Bluff and 2 kilometers from Plain Dealing. The letters "U S" are cut on tree above bench. Elevation, 104.3281.

T. B. M. 261 B.—Boat spike in root of a 0.3-meter white oak, 3 meters south of Plain Dealing-Millers Bluff road where it crosses small depression. The letters "U S" are cut on tree above bench. Elevation, 116.8777.

T. B. M. 261 C.—Boat spike in root of a 0.2-meter blackjack, two meters south of the Plain Dealing-Millers Bluff road. The tree has the letters "U S" cut on it above bench. Elevation, 121.6686.

T. B. M. 261 D.—Boat spike in root of a 0.1-meter pin oak on south edge of the Plain Dealing-Millers Bluff road, at west end of cultivated field owned by Boston Smith (colored). The letters "U S" are cut on tree above bench. Elevation, 105.5675.

T. B. M. 261 E.—Boat spike in root of a 0.3-meter red oak at north edge of the

Plain Dealing-Millers Bluff road. The letters "U S" are cut on tree above bench. Elevation, 102.0896.

T. B. M. 261 F.—Boat spike in root of a 0.3-meter red oak, 2 meters south of the Plain Dealing-Millers Bluff road, west of cabin of S. P. Palmer. The letters "U S" are cut on tree above bench. Elevation, 106.6085.

T. B. M. 261 H.—Boat spike in root of a 0.2-meter red oak, 2 meters south of the Plain Dealing-Millers Bluff road, 10 meters south of east end of field around C. H. Harrison's dwelling. The letters "U S" are cut on tree above bench. Elevation, 104.2276.

T. B. M. 261 I.—Boat spike in the west prong of a two-pronged pine, one prong, 0.2 meters in diameter, having been cut off to make bench. It is 15 meters east of road, 40 meters east of house owned by Jake Lusk at Millers Bluff. Elevation, 76.7132.

P. B. M. Lusk.—Pipestone bench at Millers Bluff, Bossier Parish, La. In the southwest corner of yard of Jake Lusk, 5 meters north of road and 400 meters from bank of Red River at Lusks Ferry and on edge of crest of hills known as Millers Bluff. Elevation, 76.0236.

P. R. P. 25. (*Red River survey*).—Pipestone bench. Is 250 feet from left bank of Red River and 160 feet below Posten Bayou near mouth. Elevation, 66.6097.

P. B. M. Plain Dealing.—Pipestone bench at Plain Dealing, Bossier Parish, La. Is 100 meters north of depot, 18 meters west of St. Louis Southwestern Railway track at a point 10 meters south of point of curvature. Elevation, 85.5566.

T. B. M. 262.—Boat spike in root of a 0.6-meter pine, 20 meters east of track, 25 meters south of milepost 424, and at north end of first cut north of Antrim, La. The letters "U S" are cut on tree above bench. Elevation, 84.1295.

T. B. M. 263.—Boat spike in root of a 0.3-meter pine, 20 meters west of track, 6 telegraph poles north of trestle 45. The letters "U S" are cut on tree above bench. Elevation, 79.7142.

T. B. M. 264.—Boat spike in root of a 0.5-meter pine, 20 meters west of track, 3½ telegraph poles north of trestle 48, and about 1 kilometer south of water tank. The letters "U S" are cut on tree above bench. Elevation, 69.2533.

T. B. M. 265.—Boat spike in root of a 0.2-meter post oak, 20 meters west of track, 2½ telegraph poles south of milepost 429. The letters "U S" are cut on tree above bench. Elevation, 73.1020.

T. B. M. 267.—Boat spike in root of a 0.4-meter red oak, 28 meters west of track, 5 meters west of wagon road, 3 telegraph poles north of Alden Bridge, 40 meters east of hotel. The letters "U S" are cut on tree above bench. Elevation, 72.5553.

P. B. M. Alden Bridge.—Pipestone bench at Alden Bridge, Bossier Parish, La., on northeast side of yard, 3.6 meters from hotel building, 80 meters west of main track of the St. Louis Southwestern Railway at a point 125 meters northeast of depot. Elevation, 71.8728.

T. B. M. 268.—Boat spike in root of a 0.3-meter post oak, 20 meters east of track, 40 meters south of milepost 433. The letters "U S" are cut on tree above bench. Elevation, 70.9426.

T. B. M. 269.—Boat spike in root of a 0.3-meter post oak, 25 meters west of track, and about 50 meters south of milepost 435. The letters "U S" are cut on tree above bench. Elevation, 71.2140.

T. B. M. 270.—Boat spike in root of a 0.4-meter pin oak, 30 meters west of track, and 1 telegraph pole north of depot at Benton, La. The letters "U S" are cut on tree above bench. Elevation, 71.6160.

T. B. M. 270 A.—Boat spike in root of a 0.4-meter red oak on road from Benton to Red River and 10 meters east of road on Abraham place. Elevation, 85.2438.

T. B. M 270 B.—Boat spike in root of a 0.9-meter red oak, 10 meters east of road from Benton to Red River. The letters "U S" are cut on tree above bench. Elevation, 72.9891.

T. B. M. 270 C.—Boat spike in root of a 0.8-meter red oak, 50 meters from left bank of Red River at Hurricane Bluff Ferry and at south edge of road where road forks. Elevation, 65.2312.

P. B. M. Hurricane Bluff.—Pipestone bench at Hurricane Bluff, Bossier Parish, La. Is 70 meters from left bank of Red River and in yard to residence of Walter Ivory, 20 meters from road to Hurricane Bluff Ferry. Elevation, 64.5512.

P. R. P. 30 C.—Is top of boss to standard bench mark pipe (no stone). Bench is 1,650 feet from river and 1,000 feet above mouth of small bayou at Hurricane Bluff, Bossier Parish, La. Elevation, 75.9214.

P. B. M. Benton.—Pipestone bench at Benton, Bossier Parish, La., in northeast corner of section-house yard. Elevation, 70.2105.

T. B. M. 271.—Boat spike in root of a 0.5-meter sycamore, 20 meters west of track, 9 telegraph poles north of milepost 439, 2½ telegraph poles south of trestle 70. The letters "U S" are cut on tree above bench. Elevation, 62.1655.

T. B. M. 273.—Boat spike in root of a 0.3-meter cottonwood, 200 meters east of track, 8 telegraph poles north of milepost 442, 1 pole north of trestle 77. Elevation, 60.5355.

T. B. M. 274.—Is an X cut on third brick of second offset course from northwest corner of brick chimney to a deserted cabin, 60 meters west of track, 3½ telegraph poles north of milepost 443. Plantation road crosses track and runs in front of bench. The letters "U S" are cut in the course of brick just above bench. Elevation, 60.3761.

P. R. P. 32 (*Red River survey*).—Pipestone bench on plantation of T. J. Vance, in front of plantation house, and on top of levee about 420 feet above Benoit Bayou. Elevation, 61.5761.

T. B. M. 276.—Boat spike in root of a 1-meter elm, 40 meters east of track, 4½ telegraph poles south of milepost 445, and ½ pole north of trestle 86. The letters "U S" are cut on tree above bench. Elevation, 58.7034.

T. B. M. 277.—Boat spike in root of a 1-meter elm, 20 meters east of track at first wagon-road crossing south of Brownlee Station, at trestle 90, and about 500 meters south of milepost 446. The letters "U S" are cut on a tree above bench. Elevation, 58.8786.

P. B. M. 45 = △ W. base.—Pipestone bench on east side of Red River, opposite Shreveport, about 200 meters from Bossier end of Vicksburg, Shreveport and Pacific bridge over Red River, 30 meters southeast of track. Bench is covered by southwest slope of levee and is marked by a post set over a bench and painted white. Post is marked "P. B. M. 45." Elevation by line from Delta to Coushatta, La., 58.3703. Elevation, 58.3301.

B. M. "B. P." (*Not Bayou Pierre survey B. M. 2*).—Is + cut on top capstone of retaining wall on southwest side of Vicksburg, Shreveport and Pacific Railway bridge at Shreveport, Caddo Parish, La. Elevation, 62.9754.

P. B. M. 46.—Pipestone bench in northwest corner of yard of the public building at Shreveport, Caddo Parish, La. Bench is 1.3 meters east and 0.5 meter south of fence corner, 28 meters north of northwest corner of building. Elevation by line from Delta to Coushatta, La., 65.8447. Elevation, 65.7964.

PARKEVILLE, LA., TO GREENVILLE, MISS., VIA ARKANSAS CITY, ARK.

P. R. P. Parkeville.—See descriptions, Monroe, La., to Little Rock, Ark., p. 1469.

T. B. M. 74.—See descriptions, Monroe, La., to Little Rock, Ark., p. 1469.

T. B. M. 20.—Is wire nail in root of a 0.4-meter honey locust on road where lane turns off leading to Ouachita City through Sandidge place, and about 20 meters southwest of P. R. P. Sandidge. Elevation, 32.8010.

P. R. P. Sandidge.—Pipe-flange bench on Sandidge place on Bayou Bartholomew, Morehouse Parish, La. Bench is about 10 meters north of bank of bayou in southwest corner of field at end of lane. Elevation, 33.3437.

T. B. M. 21.—Is a wire nail in root of a 0.7 meter oak on right bank of bayou at lower end of Sandidge place. Elevation, 31.5148.

P. R. P. Myers.—Pipe-flange bench on widow Myers's place on Bayou Bartholomew, Morehouse Parish, La. Bench is about 20 meters south of right top bank of bayou, in northwest corner of field at end of lane leading to Marble place. Elevation, 33.8281.

T. B. M. 27.—Is wire nail in root of a 1.4-meter white oak at upper end of lane between Williams and Jones places on right bank of bayou, 25 meters southwest of P. R. P. Williams. Elevation, 32.6780.

P. R. P. Williams.—Pipe-flange bench on Jones place, on Bayou Bartholomew, Morehouse Parish, La. Bench is 20 meters north of right bank of bayou, in southwest corner of yard around second cabin below residence. Elevation, 32.5900.

T. M. B. 28.—Wire nail in root of a 0.8-meter sweet gum at upper end of lane between Jones and Anderson places. Elevation, 33.6876.

P. R. P. Anderson.—Pipe-flange bench on Jones place on Bayou Bartholomew, Morehouse Parish, La. Bench is about 20 meters east of end of lane cutting across neck to the Williams place, and 15 meters south of bank of bayou. Elevation, 33.6830.

P. R. P. Bonner.—Pipe-flange bench on the Bonner place on Bayou Bartholomew, Morehouse Parish, La. Bench is in the northwest corner of yard around cabin on the lower end of the place. The cabin is where the road comes back to the bayou after crossing the neck that includes what is known as the "Round Turns." Elevation, 34.1562.

T. B. M. 33.—Is wire nail in root of a 0.7-meter black gum, on right bank of bayou in front of third cabin below gin (or sawmill) on Bonner place. Elevation, 34.8879.

T. B. M. 35.—Is wire nail in root of a 1.2-meter oak, on bayou side of road, 350 meters below residence at Pecan Landing on the Davis place. Elevation, 35.0885.

T. B. M. 36.—Is wire nail in root of a 0.4-meter hickory, on right bank of bayou and 300 meters below Ward's residence. Elevation, 35.3730.

P. R. P. Davis 2.—Pipe-flange bench on the Ward place, Bayou Bartholomew, Morehouse Parish, La. Bench is in the southwest corner of field adjoining yard to second cabin below the residence. Elevation, 35.3519.

T. B. M. 37.—Is wire nail in root of a 1.2-meter oak on right bank of bayou, 200 meters below Morgan's house and 100 meters below gin. Elevation, 34.7797.

T. B. M. 38.—Is wire nail in root of a 0.4-meter oak on bayou side of road where it forks to cross bayou at Wards Ferry. Elevation, 34.9574.

P. R. P. Ward.—Pipe-flange bench at Wards Ferry, Bayou Bartholomew, Morehouse Parish, La. Bench is 3 meters northeast of bridge across drain on Hope place, and 10 meters north of right bank of bayou. Elevation, 35.7765.

T. B. M. 41.—Is boat spike in root of a 0.3-meter pine on left bank of bayou and in front of residence on Miller place. Elevation, 35.9969.

T. B. M. 43.—Boat spike in root of a 1-meter oak on bayou side of road and 50 meters north of Harry Wells's house. Elevation, 36.7563.

P. R. P. Wells.—Pipe-flange bench on Wells's place, Bayou Bartholomew, Morehouse Parish, La. Bench is in northwest corner of field which is east of first cabin east of Wells's residence and 10 meters south of left bank of bayou. Elevation, 36.6355.

T. B. M. 46.—Boat spike in root of a 0.5-meter sycamore, 150 meters below ditch from swamp to bayou on Mound place, and 30 meters from left bank of bayou. Elevation, 37.7140.

P. R. P. Mound.—Bench disturbed.

T. B. M. 49.—Boat spike in root of a 0.9-meter sweet gum on bayou side of road, 250 meters below church, and 10 meters above end of lane between Watts and Nunn places. Elevation, 36.4454.

T. B. M. 50.—Boat spike in root of a 1.2-meter oak at Lindgrove Landing on left bank of bayou, about 40 meters above junction of road from Bonita with bayou. The letters "U S" are cut on tree above bench. Elevation, 38.1172.

P. R. P. Lindgrove.—Pipe-flange bench at Lindgrove Landing, Bayou Bartholomew, Morehouse Parish, La. Bench is in west corner of field where road from Bonita comes to bayou bank. It is 50 meters south of abandoned store and 50 meters southeast of left bank of bayou. Elevation, 38.3789.

T. B. M. 51.—Is wire nail in root of a 0.6-meter hickory on south side of Bonita-Lindgrove road, on the Watts place, and 125 meters above Scott's place. Elevation, 37.5884.

T. B. M. 52.—Boat spike in root of a 0.7-meter sweet gum on north side of Bonita-Lindgrove road and about 75 meters above line between Denham and Walker places. Elevation, 34.5848.

T. B. M. 53.—Boat spike in root of a 0.5-meter sweet gum, 15 meters west of the Houston, Central Arkansas and Northern Railway track and 75 meters southwest of section house. Elevation, 38.3168.

P. B. M. Bonita.—Pipe-flange bench at Bonita, Morehouse Parish, La. Bench is in the northeast corner of garden belonging to section house of Houston, Central Arkansas and Northern Railway. It is about 16 meters east of track and 45 meters north of section house. Elevation, 38.5844.

T. B. M. 54.—Is wire nail in root of a 0.15-meter elm on east side of track and half way between third and fourth telegraph poles above milepost 498, at edge of woods and 20 meters above field. Elevation, 36.9076.

T. B. M. 55.—Wire nail in root of a 0.5-meter white oak, 16 meters east of track and 225 meters below first cattle gap below milepost 497. Elevation, 37.0865.

T. B. M. 56.—Nail in root of a 0.3-meter ash, 25 meters east of track and just below first cattle gap above Jones Station. Elevation, 38.5643.

P. B. M. Jones.—Pipe-flange bench at Jones Station, Morehouse Parish, La. Bench is about 20 meters east of Houston, Central Arkansas and Northern Railway track and 15 meters south of milepost 496 and in corner of field opposite station platform. Elevation, 38.7067.

T. B. M. 57.—Wire nail in root of a 0.7-meter red oak near point of curvature of third curve above Jones Station and on east side of track. Elevation, 37.8890.

T. B. M. 58.—Wire nail in root of a 0.8-meter pine, 100 meters east of gin in field above third curve north of Jones Station, where track comes within 100 meters of bayou, 20 meters from road crossing track. Elevation, 38.6287.

P. R. P. La.-Ark.—Pipe-flange bench about 500 meters south of line between Louisiana and Arkansas and in Morehouse Parish, La. Bench is in edge of field on south side of road, 15 meters east of track and 80 meters east of left bank of Bayou Bartholomew. Elevation, 38.8184.

T. B. M. 59.—Is wire nail in root of a 0.4-meter sweet gum on east side of track at first telegraph pole south of milepost 492. Elevation, 38.7958.

T. B. M. 60.—Wire nail in root of a 0.4-meter pin oak on east side of track and 7 telegraph poles below milepost 491. Elevation, 38.1887.

T. B. M. 61.—Wire nail in root of a 0.3-meter sweet gum on east side of track and 6 telegraph poles below milepost 490. Elevation, 38.6137.

T. B. M. 62.—Wire nail in root of a 0.4-meter oak 6 telegraph poles below milepost 489. Elevation, 39.3352.

T. B. M. 63.—Wire nail in root of a 1.4-meter oak on west side of track and about 300 meters above station at Wilmot. Elevation, 40.8813.

P. B. M. Wilmot.—Pipe-flange bench at Wilmot, Ashley County, Ark. Is in southeast corner of yard around Hotel Chesnutt, about 50 meters northeast of depot and 30 meters west of track. Elevation, 41.0407.

T. B. M. 64.—Wire nail in root of a 0.2-meter elm, 20 meters west of track and 10 meters above milepost 487. Elevation, 39.5520.

T. B. M. 65.—Wire nail in root of a 1-meter oak 15 meters west of track and 6 telegraph poles above milepost 486. Elevation, 40.4426.

T. B. M. 66.—Wire nail in root of a 0.4-meter black gum 20 meters west of track, 60 meters east of left bank of Bayou Bartholomew, and 5½ telegraph poles below milepost 485. Elevation, 40.7661.

P. R. P. Noble 1.—Pipe-flange bench on James Noble's place on Bayou Bartholomew, Ashley County, Ark. Bench is about 40 meters west of Houston, Central Arkansas and Northern Railway track at its nearest point to the bayou. Elevation, 40.8578.

T. B. M. 67.—Wire nail in root of a 0.2-meter elm 10 meters east of track, opposite south end of turnout and 3 telegraph poles below milepost 484, near Parkdale. Elevation, 41.2416.

Gauge B. M. D.—Wire nail in root of a 0.8-meter white oak on left bank of Bayou Bartholomew, 30 meters above lane to railroad on Baily King's place. Elevation, 42.3178.

P. B. M. Parkdale.—Pipe-flange bench at Parkdale, Ashley County, Ark. Bench is in northeast corner of section-house yard and 6 meters west of Houston, Central Arkansas and Northern Railway track. Elevation, 41.6661.

T. B. M. 69.—Wire nail in root of a 1.1-meter sweet gum, 15 meters east of track and 9 telegraph poles above milepost 483. Elevation, 41.9775.

T. B. M. 70.—Wire nail in root of a 0.3-meter black gum, 20 meters west of track and 11½ telegraph poles above milepost 482. Elevation, 42.1620.

T. B. M. 71.—Nail in root of a 0.4-meter cottonwood, 20 meters east of track and one-half pole above division line, sections 70-71. Elevation, 42.2134.

T. B. M. 72.—Wire nail in root of a 0.3-meter sweet gum, 20 meters east of track and 1 telegraph pole above first cattle gap below curve at Sunshine. Elevation, 41.3200.

P. B. M. Sunshine.—Pipe-flange bench at Sunshine, Ashley County, Ark. Bench is in north corner of yard to cabin of Ed Honeycutt, about 15 meters east of track and 2 telegraph poles south of milepost 479. Elevation, 42.1385.

T. B. M. 74.—Wire nail in root of a 0.3-meter pignut hickory, 20 meters east of track and three-fourths telegraph pole above milepost 478. Elevation, 40.5672.

T. B. M. 76.—Wire nail in root of a 0.3-meter elm, 20 meters east of track and 1 telegraph pole below tank at Portland. Elevation, 43.8392.

P. B. M. Portland.—Pipe-flange bench at Portland, Ashley County, Ark. Bench is about 20 meters east of track and in southeast corner of section-house yard. Elevation, 45.0283.

T. B. M. 78.—Wire nail in root of a 1.3-meter white oak, 40 meters west of track and 6 telegraph poles below milepost 474. Elevation, 43.5437.

T. B. M. 79.—Wire nail in root of a 0.3-meter white oak, 30 meters east of track and one-half pole below division line of sections 69-70. Elevation, 43.9378.

T. B. M. 80.—Wire nail in root of a 0.8-meter sweet gum, 20 meters west of track and 13 telegraph poles below milepost 472. Elevation, 43.7445.

T. B. M. 81.—Wire nail in root of a 0.3-meter sweet gum on Cruis place, 15 meters east of track and 5 telegraph poles below gin. Elevation, 43.1971.

T. B. M. 82.—Wire nail in root of a 0.2-meter white oak, 15 meters east of track and 9 telegraph poles below milepost 470. Elevation, 43.3749.

T. B. M. 83.—Wire nail in root of a 0.3-meter sweet gum, 15 meters north of track and 4 telegraph poles north of milepost 470. Elevation, 44.2461.

P. B. M. Kidd.—Pipe-flange bench at Kidds Spur, Ashley County, Ark. Bench is in northwest corner of P. L. McGurdy's yard and about 25 meters east of Houston, Central Arkansas and Northern Railway track. Elevation, 44.0492.

T. B. M. 84.—Wire nail in root of a 0.5-meter hickory, 10 meters west of track and 5 telegraph poles above milepost 469. Elevation, 45.3969.

T. B. M. 85.—Wire nail in root of a 0.8-meter sweet gum, 15 meters east of track and 3½ telegraph poles below milepost 468. Elevation, 44.7783.

T. B. M. 86.—Wire nail in root of a 0.4-meter willow oak, 15 meters east of track and 3 telegraph poles below sign reading "Station 1 mile." Elevation, 44.3416.

T. B. M. 87.—Wire nail in root of a 0.4-meter honey locust, immediately south of church, in front of schoolhouse, on west side of track, opposite end of switch, and 7 telegraph poles below station at Morrell. Elevation, 45.7810.

P. R. P. Morrell.—Pipe-flange bench at Morrell, Ashley County, Ark. Bench is in west corner of yard to section house and about 20 meters west of Houston, Central Arkansas and Northern Railway track. Elevation, 45.8371.

T. B. M. 89.—Wire nail in root of a 0.4-meter sweet gum, 20 meters west of track and 6½ telegraph poles below milepost 465. Elevation, 44.4823.

T. B. M. 90.—Wire nail in root of a 0.2-meter oak, 25 meters east of track and 3 telegraph poles above the Ashley-Drew county line. Elevation, 44.7533.

T. B. M. 91.—Wire nail in root of a 0.3-meter black gum, 20 meters west of track and one-half telegraph pole above upper end of first curve above milepost 464. Elevation, 45.5805.

T. B. M. 92.—Wire nail in root of a 0.2-meter hickory, 15 meters east of track and 9 telegraph poles below sign reading "Station one mile." Elevation, 45.4259.

T. B. M. 93.—Wire nail in root of a 0.3-meter hickory, 20 meters east of track, 4½ telegraph poles below milepost 461, and 50 meters below section house at Hudspeth. Elevation, 46.5001.

P. B. M. Hudspeth.—Pipe-flange bench at Hudspeth, Chicot County, Ark. Bench is in southeast corner of yard to section house and about 15 meters east of Houston, Central Arkansas and Northern Railway track. Elevation, 46.7008.

T. B. M. 94—Wire nail in root of a 0.5-meter hickory, 20 meters west of track and 6 telegraph poles below milepost 459. Elevation, 48.2071.

T. B. M. 95.—Wire nail in root of a 0.3-meter oak, on west edge of railway right of way, and 1 telegraph pole above second cattle gap below milepost 458. Elevation, 47.4652.

T. B. M. 98.—Wire nail in root of a 0.4-meter cottonwood, on west side of right of way, 4 telegraph poles below crossing of Warren branch of St. Louis, Iron Mountain and Southern Railroad. Elevation, 47.9015.

P. B. M. Dermott.—Pipe-flange bench at Dermott, Chicot County, Ark. Bench is in the northwest corner of yard to section house and 15 meters west of Houston, Central Arkansas and Northern Railway track. Elevation, 48.8509.

T. B. M. 99a.—Wire nail in root of a 0.4-meter pignut hickory at north edge of right of way and ½ telegraph pole east of bridge 614 on Warren branch of St. Louis, Iron Mountain and Southern Railroad. Elevation, 49.2648.

T. B. M. 100a.—Bench disturbed.

T. B. M. 101a.—Wire nail in root of a 1.1-meter red oak on north edge of right of way one-half telegraph pole east of bridge 619. Elevation, 46.8227.

T. B. M. 102a—Wire nail in root of a 0.8-meter cottonwood on south edge of right of way opposite first telegraph pole west of road crossing at Baxter. Elevation, 49.2239.

P. R. P. Baxter.—Pipe-flange bench at Baxter, Drew County, Ark. Bench is in the east corner of yard of S. A. Duke, about 30 meters southwest of track of Warren branch of St. Louis, Iron Mountain and Southern Railway, about 50 meters west of west end of bridge across Bayou Bartholomew. Elevation, 49.3844.

T. B. M. 99.—Wire nail in root of a 0.2 meter maple on east edge of right of way, 1 telegraph pole above milepost 454. Elevation, 47.7845.

T. B. M. 100.—Wire nail in root of a 0.2 meter persimmon on east edge of right of way, and 1 telegraph pole above milepost 453. Elevation, 47.4296.

T. B. M. 101.—Wire nail in root of a 0.2 meter oak, on east edge of right of way, 3½ telegraph poles above milepost 452. Elevation, 47.8064.

T. B. M. 102.—Wire nail in root of a 0.4-meter oak, on east side of right of way, 2½ telegraph poles above milepost 451. Elevation, 48.2448.

T. B. M. 103.—Wire nail in root of a 0.4-meter sweet gum, on edge of right of way, 2½ telegraph poles above milepost 450. Elevation, 49.0665.

T. B. M. 104.—Wire nail in root of a 0.6-meter willow oak, on east edge of right of way, and 2½ telegraph poles from milepost 449. Elevation, 48.2860.

T. B. M. 105.—Wire nail in root of a 0.2 meter honey locust, on west edge of right of way, south side of wagon road, and 2½ telegraph poles below milepost 448. Elevation, 51.0217.

T. B. M. 106a.—Wire nail in root of a 0.4-meter oak, on west side of track in yard surrounding cabin about 540 meters north of McGehee Station. Elevation, 51.2855.

P. B. M. G. (*C. and G. S.*).—At McGehee, Desha County, Ark. Was center of cross in head of copper bolt, leaded horizontally into a brick chimney on the north side of a small whitewashed house west of the line of the St. Louis, Iron Mountain and Southern road. The brick is in the ninth course from the ground; the house the seventh one north of A. McGehee's store. The copper bolt had been taken out, but the center of cavity was taken as the point and will vary only a few millimeters from the original point. Elevation, 51.7706.

P. B. M. McGehee.—Pipe-flange bench at McGehee, Desha County, Ark. Bench is in west corner of yard of cabin opposite the north end of switch and west of the St. Louis, Iron Mountain and Southern Railway track. The cabin is the same one used for the C. and G. S. benchmark G, above described. Elevation, 51.4485.

T. B. M. 107.—Wire nail in root of a 0.4-meter elm on south edge of right of way, immediately west of first road crossing east of milepost 447. Elevation, 50.5732.

T. B. M. 108.—Wire nail in root of a 1-meter red oak on south edge of right of way, 2½ telegraph poles east of milepost 450. Elevation, 49.6396.

T. B. M. 109.—Wire nail in root of a 0.3-meter oak on south edge of right of way, 8½ telegraph poles above milepost 451. Elevation, 47.7673.

T. B. M. 110.—Wire nail in root of an 0.8-meter black gum, on south side of right of way, 3½ telegraph poles east of east end of first trestle east of section house at Trippe. Elevation, 47.6064.

P. B. M. Trippe.—Pipe-flange bench at Trippe Junction, Desha County, Ark Bench is in south corner of R. D. Crenshaw's yard, north of the Warren branch of the St. Louis, Iron Mountain and Southern Railway track. Elevation, 50.2323.

T. B. M. 117=Levee B. M.—Is iron pipe on west slope of railway dump on west slope of levee and 100 meters from bank of Mississippi River. Elevation, 50.2461.

P. B. M. F. (*C. and G. S.*).—At Arkansas City, Desha County, Ark. Is bottom of square cut in the top of an 8 by 8 inch granite post set in ground about 2 meters south of west corner of small house southwest of railroad station. It is lettered thus: $\overset{\text{U S}}{\underset{\text{B M}}{\square}}$ Coast and Geodetic survey elevation, 42.2140 meters, Gulf level. Elevation, 48.3833.

B. M. A (*Ewens, 1886*).—Top of a large railroad spike in root of a 3½-foot elm in same yard as P. B. M. F. Elevation, 48.2930.

M. R. C. Stone $^{6.3}_{3}$.—Is top of stone post N. 79° 50′ W., 420 meters from railway shops below Arkansas City. Is 250 meters from edge of woods. Elevation, 47.6410.

M. R. C. Stone $^{6.3}_{2}$.—Is stone on inner slope of levee on Clark place, opposite Arkansas City, 1,600 meters below Shelby's store, and 650 meters below junction of levee, and 620 meters above another junction. Elevation, 50.3225.

P. B. M. 84 (*M. R. C.*).—Bench disturbed.

T. B. M. 120.—Wire nail in root of a 0.05-meter honey locust on Port Anderson place, 560 meters below division line. Elevation, 47.4326.

P. B. M. 85 (*M. R. C.*)—Is top of brass bolt in top of stone post set in southeast corner of yard of Thomas S. Kennedy's plantation, at Port Anderson, Bolivar County, Miss. Stone is 25 meters east of a brick cistern at southeast corner of house, and 40 meters southeast of brick cistern at northeast corner of house. It is 55 meters back from levee and about 160 meters above an abrupt turn in levee. Top of bolt is 5 millimeters above top of stone. Mississippi River Commission elevation, 47.7646 meters, Cairo datum. Elevation, 47.7892.

T. B. M. 121=Levee B. M.—Is iron pipe at levee station 3710, at angle in levee, 425 meters above second angle below Port Anderson residence. Elevation, 50.2487.

P. B. M. 86. (*M. R. C*).—Is top of brass bolt in top of stone post planted on lands of Thomas S. Kennedy, 300 meters above Offutts Landing, Washington County, Miss. The stone is in southwest corner of field, 1 meter back of old levee, 25 meters north of new levee, which marks the boundary line between Bolivar and Washington counties, and is in Bolivar County, Miss. Top of bolt is 4 millimeters above top of stone. Mississippi River Commission elevation, 47.2875. Elevation, 47.3040.

T. B. M. 122=Levee B. M.—At levee station 3790, and 1,290 meters below Cousins store at Offutts Landing. Elevation, 49.7942.

P. B. M. Millers Bend.—At Millers Bend, Washington County, Miss. Bench was set by Asst. Engineer J. T. Ashler, of the levee board, during the winter of 1892–93. Is top of brass bolt in top of a 6 by 6 inch granite post between two trees, about 20 meters east of angle in levee at Millers Bend. Elevation, 44.8459.

T. B. M. 139.—Wire nail in root of a 0.2-meter thorn on east side of Walnut street, Greenville, Miss., and 40 meters south of where levee leaves street. Elevation, 44.4871.

B. M. O. (*M. R. C. 1893*).—At Greenville, Washington County, Miss. Is in southwest corner of Blanton burial ground, north of Main and east of Locust streets. It is in the fence corner, and consists of a copper bolt leaded vertically in upper surface of an 18″ x 18″ x 4″ tile placed about 3 feet below ground. The face of tile is marked:

Mississippi River Commission
U S
B △ M
1893

Tile is surmounted by an iron pipe placed on the tile over the copper bolt. Elevation, 44.2776.

C. and G. S. P. B. M. Greenville, No 1.—At Greenville, Washington County, Miss., on corrugated iron doorsill on north side, near northwest corner of building known as the "bank building." The precise point is not marked, but can be defined as the point near the back side and west end of sill, 32 centimeters from front face, 55 millimeters from door strip, and 9 centimeters from west door jamb. Coast and Geodetic Survey elevation, 39.9630 meters, Gulf level. Mississippi River Commission elevation, 46.0891. Elevation by line from Delta, La., to Greenville, Miss., via Yazoo City, Miss., 46.2359. Elevation, 46.1343.

GLENDORA TO FARMERVILLE AND STEINS BLUFF, LA.

T. B. M. 79.—See descriptions, Monroe, La., to Little Rock, Ark., p. 1468.

P. R. P. Glendora.—See descriptions, Monroe, La., to Little Rock, Ark., p. 1468.

T. B. M. 29.—Small boat spike in root of a 1-meter white oak, 16 meters east of small bridge and on right side of wood road from Hugh Young place to opposite Port Union. Elevation, 30.1655.

P. B. M. Port Union.—Pipe-flange bench in south corner of R. C. Webb's yard at Port Union Landing, Union Parish, La., about 14½ meters south of south corner of dwelling and 60 meters from right bank of river. Elevation, 31.9582.

T. B. M. 28.—Boat spike in surface route of a 0.3 and a 0.7 meter twin gum at foot of lane, 18 meters southwest of graveyard, 111 meters from right bank of river and about 580 meters above Port Union Landing. Elevation, 31.0616.

T. B. M. 27.—Boat spike in root of a 0.7-meter red oak, to right of road and at top of west bank of slough. Elevation, 29.8905.

T. B. M. 26.—Boat spike in root of a 0.5-meter post oak, to left of road at top of small hill after crossing small branch, and 75 meters east of fence corner around first clearing east of W. T. Hay's. Elevation, 35.9719.

P. B. M. Hay.—Pipe-flange bench in northeast corner of W. T. Hay's yard, Union Parish, La., 21.4 meters from northeast corner of dwelling and 30 meters south of public road. Elevation, 47.3825.

T. B. M. 25.—Boat spike in root of a 0.4-meter pin oak, to right of road 406 meters east of Point Pleasant Baptist Church in small swale, and about 200 meters west of 17-mile board. Elevation, 51.6065.

T. B. M. 24.—Boat spike in root of a 0.3-meter pin oak in front of J. T. Slack's house at top of west hill leading to Rocky Branch. Elevation, 53.9563.

T. B. M. 23.—Boat spike in root of a 0.6-meter red oak, to left of road at top of hill, about 300 meters east, along road from John Harris house, which sits back in field. Elevation, 57.4488.

T. B. M. 22.—Boat spike in root of a 1.4-meter red oak, on right of road at junction of main road with road to Colsons post-office. Tree is very conspicuous, being a large spreading oak at top of hill. Elevation, 61.6822.

T. B. M. 21.—Boat spike in root of a 0.4-meter white oak, on left of road and between roads at foot of first hill beyond White's house. Elevation, 52.5994.

P. B. M. White.—Pipe-flange bench in north corner of yard of William White, Union Parish, La., at forks of road coming from Farmerville and going to Ouachita City and Port Union. Is 5 meters south of first road, 25 meters east of second, and 9 meters from north corner of house. Elevation, 60.7552.

T. B. M. 20.—Boat spike in root of a 0.4 and a 0.2 meter twin pine, to left of road at top of hill after crossing creek, about 350 meters from Jim Simpson's house and 40 meters west of road to Turkey Bluff. Trees have been deadened. Elevation, 58.8090.

T. B. M. 19.—Boat spike in root of a 0.5-meter pine, to left of road, 10 meters east of a small branch, which is about 350 meters east of Jim Purdue's residence. Elevation, 53.5558.

T. B. M. 18.—Boat spike in root of a 0.6-meter white oak, to right of road and at top of west hill at the foot of which is Sixteenth or Tucker Creek. Elevation, 39.9699.

T. B. M. 17.—Boat spike in root of a 0.4-meter hickory, 3½ meters north of road and 40 meters from southeast corner of John Ward's house. Elevation, 61.4676.

P. B. M. Rogers.—Pipe-flange bench in southeast corner of Pattison Roger's yard on "Lower road," Farmerville to Port Union, and about 7¾ miles from former place. It is 0.6 meter from front fence, 5 meters west of fence dividing yard from horse lot, 3.1 meters southeast of well, and 9.5 meters southeast of cabin. Elevation, 59.6349.

T. B. M. 16.—Boat spike in root of a twin cherry, each 0.5 meter diameter, about 75 meters west of cross road to Echels Ford and 250 meters west of old church. Elevation, 61.3851.

T. B. M. 15.—Boat spike in root of an 0.8-meter sweet gum at forks of and between two roads, just west of small branch which is 1.2 kilometers east of W. W. Taylor's dwelling. Elevation, 29.4214.

T. B. M. 14.—Boat spike in root of an 0.8-meter pine, to right of road to Port Union, 10 meters from corner of fence and in front of W. W. Taylor's dwelling, which is about 350 meters south of road. Elevation, 42.3406.

T. B. M. 11.—Spike in root of a 0.3-meter post oak, to left of road, about 250 meters along road from side road to Jack Kennedy's gin and about 75 meters west of fork of Lower and Middle roads to Port Union. Elevation, 57.0912.

T. B. M. 10.—Spike in root of a 0.5-meter post oak, to left of road, about 50 meters south of cabin and 30 meters southwest of a big well (not curbed), about 80 meters east of a small branch and 150 meters east of Hoffman's house. Elevation, 35.9037.

T. B. M. 9.—Spike in root of 0.4-meter white oak, on right of road at top of hill and at end of level stretch east of Underwood's dwelling. Elevation, 46.2001.

T. B. M. 8.—Spike in root of a 0.2-meter post oak, 10 meters north of road and 250 meters west of Jim Undersood's house. Elevation, 42.2197.

T. B. M. 7.—Boat spike in root of a 0.4-meter sweet gum, on top of second hill from Farmerville and to left of road opposite two cabins in field to left. Elevation, 52.9058.

P. B. M. Farmerville.—Pipe-flange bench in the northwest corner of court-house yard at Farmerville, Union Parish, La. Elevation, 60.8811.

T. B. M. 3.—Boat spike in root of a 1-meter pine on left of road, Farmerville to Forks Ferry, at junction of road and trail leading to ferry, and just at the top of the large hill at the same place on main road. Elevation, 66.2503.

T. B. M. 4.—Boat spike in root of a 1-meter sweet gum, to left of road, 2 meters from well, about 75 meters from old sawmill, and about 200 meters along road from Forks Ferry. On left bank of bayou. Elevation, 28.6701.

T. B. M. 6.—Boat spike in root of a 0.4-meter black gum, on south side of lane to J. T. Brantley's house at Scotts Bluff and 8 meters from corner of fence. Elevation, 41.6142.

P. B. M. Scott.—Pipe-flange bench on right top bank and 30 meters back of right second bank of Bayou Cornie at Scotts Bluff, Union Parish, La. Is 19 meters below site of old warehouse and witnessed by three triangular blazed trees as follows: Bench is on line with and halfway between 0.7-meter black gum, north 1½ meters, and 0.5-meter black gum, south 1.5 meters; and 0.5-meter pine, northeast 6 meters. Elevation, 29.2997.

B. M. Scott.—Is nail in root of a 15-inch black gum, right bank of bayou and 10 meters below site of old warehouse. Elevation, 28.8930.

P. B. M. Stein.—Pipe-flange bench at Steins Bluff, Union Parish, La. Is on northeast side and halfway between north and east corners of smallest old store. Old store is about 20 meters west of south end of warehouse. Elevation, 35.6198.

B. M. Stein.—Is nail in root of a 10-inch sweet gum on side of hill near upper outer corner of Stein's warehouse. Tree is in line with and about 15 feet north of west wall. Elevation, 31.4297.

T. B. M. 1.—Boat spike in root of a 0.3-meter white oak on left side of road from Cox Ferry to Farmerville, about 100 meters southwest of school building and 0.9 kilometer from court-house at Farmerville. Elevation, 62.5507.

B. M. Cox.—Is head of spike in root of a 36-inch post oak on right bank of bayou at Cox Ferry and just below mouth of small slough. Elevation, 26.2138.

B. M. L. (Burrowes 1883).—Is small nail in root of same tree as B. M. Cox. Burrowes elevation, 35.030 feet. Elevation, 26.0479.

P. B. M. Cox Ferry.—Pipe-flange bench on right top bank of Bayou D'Arbonne, 26 meters east or below ferry road, 12 meters from edge of bank and near small swale, and witnessed by four triangular blazed trees, viz: 0.6-meter sweet gum, 230°, 2½ meters; 0.5-meter water oak 190°, 3 meters; 1.4-meter oak, 330°, 8 meters; and 0.5-meter pin oak, 40°, 4 meters. Elevation, 27.6955.

DELTA TO COUSHATTA, LA.

C. and G. S. B. M. 215.—In Delta, Madison Parish, La., opposite Vicksburg, Miss. The end of vertical ray of five-rayed cast-iron star, used as a tie plate, in south end of parish clerk's office near court-house. Is about 4 feet from ground and 3 from southeast corner of building. Coast and Geodetic Survey elevation 27.8699 meters, Gulf level. Elevation, 34.0836. (Bench destroyed.)

C. and G. S. △ SW. base.—The cross cut on top of copper bolt leaded in top of the 14 by 14 inch limestone post marking the south end of the Delta base line. The stone stands just south of the Vicksburg, Shreveport and Pacific Railway, in the south edge of the village of Delta, Madison Parish, La., and is apparently undisturbed. It is east of the road which forms the main street of the village. Coast and Geodetic Survey elevation, 26.6242 meters, Gulf level. Elevation, 32.8374.

P. B. M. 2.—Pipestone, bench at northeast corner of the most easterly of the Vicksburg, Shreveport and Pacific Railway section houses at Mound Station, Madison Parish, La. Bench is 0.8 meter south and 0.2 meter east of northeast corner of house. Elevation, 31.5223.

P. B. M. 3.—Pipestone bench in the northeast corner of yard of Mrs. N. Thomas, at California Station, Madison Parish, La., and 400 meters south of Vicksburg, Shreveport and Pacific Railway bridge No. 25. Elevation, 33.0703.

P. B. M. 4.—Pipestone bench in southwest corner of yard around cabin and opposite store at Barnes Station, Madison Parish, La., 13.4 meters from southwest corner of cabin chimney, and 44 meters north of center of railroad siding. Elevation, 30.8796.

P. B. M. 5.—Hole in head of copper bolt leaded horizontally in south wall of court-house at Tallulah, Madison Parish, La. Bolt is 0.6 meter west of west side of main door and 0.55 meter above floor of gallery. Elevation, 34.1630.

P. B. M. 6.—Cross cut on west end of iron doorsill of south entrance of Tallulah court-house. Elevation, 33.7671.

P. B. M. 7.—Pipestone bench on east bank of Lake One, 57 meters north of east pier of Vicksburg, Shreveport and Pacific Railway bridge, and in northwesterly direction from Waddill's sawmill. Elevation, 29.7431.

P. B. M. 8.—Pipestone bench at northwest corner of store at Quebec Station, Madison Parish, La. Store is 110 meters southwest from west end of railroad siding and 60 meters southeast of east end of railroad bridge over Bayou Dispute. Elevation, 29.0637.

P. B. M. 9.—Pipestone bench on east bank of Tensas River, near Quebec, in a southerly direction from railroad bridge, and in direct range of second bent of east bridge approach, 8.7 meters south of center line of track. Elevation, 29.9959.

P. B. M. 10.—Pipestone bench at Dallas, Madison Parish, La. Bench is 2.35 meters east of brick chimney of first cabin west of Tensas River, on north side of railroad track, and 4.1 meters north of center line of track. Elevation, 29.4094.

P. B. M. 11.—Pipestone bench in northwest corner of yard of house occupied by section foreman at Waverly, Madison Parish, La. Bench is 55 meters south of center of railroad track and 20.5 meters north of house in continuation of west wall. Elevation, 30.1182.

P. B. M. 12.—Pipestone bench (pipe gone) on west bank of Bayou Maçon, near Vicksburg, Shreveport and Pacific Railway bridge. Bench is in direct range with the third bent of west bridge approach, 40 meters south of center of track and 12 meters back from bank of bayou. Witnessed by three reference trees, as follows: 0.2-meter locust, 10.8 meters distant, plain blaze; 0.2-meter red haw, 5.2 meters distant, plain blaze; and 0.25-meter bitter pecan, 4.2 meters distant, triangular blaze. Elevation, 28.8012.

P. B. M. 13.—Pipestone bench at Delhi, Richland Parish, La., in northwest corner of residence lot belonging to W. T. Insley. Bench is 27.3 meters south of center line of track, 20.4 meters east of Catholic churchyard fence, and 1 meter south and 1 meter east of northwest fence corner. Elevation, 34.9267.

B. M. Delhi.—Spike in root of a water oak about opposite Mrs. Bloom's residence and 18 meters north of track. Elevation, 34.6447.

T. B. M. 30.—Top of railroad spike in root of a small gum, 15 meters north of track and about 20 meters west of bridge 98. Elevation, 32.5142.

P. B. M. 14.—Pipestone bench at Carpenter Station, Richland Parish, La., in southwest corner of yard to cabin standing opposite railroad platform. Bench is 15.4 meters north of center of track and 23.8 meters southeast of southeast corner of cabin. Elevation, 32.5140.

P. B. M. 15.—Pipestone bench at Holly Ridge, Richland Parish, La., in yard of residence of W. F. Winstead, 23.4 meters south of front line of gallery, 1.8 meters west of main door to house, and 18.3 meters north of center line of track. Elevation, 32.0892.

P. B. M. 16.—Pipe-flange bench in court-house yard at Rayville, Richland Parish, La. Bench is 0.8 meter west of northwest corner of "L" in court-house front, 0.9 meter north of north wall, and 61 meters south of center of track. Elevation, 30.6624.

P. B. M. 17.—Hole in head of copper bolt leaded in face of "L" of court-house front, Rayville, Richland Parish, La., 0.09 meter west of north door and 0.4 meter above floor line. Elevation, 32.9917.

T. B. M. 39.—Is X in railroad spike driven in root of an elm about 15 meters south of railroad track and 400 meters east of milepost 52 from Delta. Elevation, 30.4468.

T. B. M. 40a.—On oak about 40 meters south of railroad track and 10 meters back of small store at Girard, La. Elevation, 31.0926.

P. B. M. 18.—Pipestone bench on east bank of Bœuf River, near Girard, Richland Parish, La., in a southeasterly direction from Vicksburg, Shreveport, and Pacific Railway bridge, 70.6 meters south of center line of track and in direct range of first bent east of bridge approach, 12.5 meters from river bank, and 200 meters northeast of house. Elevation, 30.5726.

P. B. M. 19.—Pipestone bench at Girard, Richland Parish, La., east side of yard of Mrs. Brashear, 4 meters east and 4.5 meters south of southeast corner of brick chimney at east end of house and 26 meters south of center line of track. Elevation, 30.3209.

P. B. M. 20.—Hole in head of copper bolt leaded in east face of brick chimney at east end of Mrs. Brashear's house at Girard, Richland Parish, La. Bolt is 0.3 meter from north face of chimney and 1 meter above springing course. Elevation, 32.4629.

T. B. M. 41a.—Is an X in top of railroad spike in root of small oak about 20 meters south of track and about 150 meters west of milepost 55 from Delta. Elevation, 30.0796.

T. B. M. 42½.—Is X on railroad spike in root of large white oak 20 meters west of tank at Crew Lake and 30 meters north of track. Elevation, 26.7401.

P. B. M. 21.—Pipestone bench in southeast corner of garden lying in a northwesterly direction from railway platform at Crew Lake Station, Richland Parish, La. Bench is 4.5 meters west of southwest corner of store, on line with front of store, and 24 meters north of center line of track. Elevation, 26.4426.

T. B. M. 46a.—Is X in top of railroad spike in root of an oak about 30 meters south of track and in front of large residence on Frank Whitehead's place. Elevation, 26.6116.

P. B. M. 23.—Pipestone bench in northeast corner of yard on plantation of F. L. Whitehead, at Gordon Station, Ouachita Parisn, La. Bench is 14.7 meters north and 9.5 meters east of northeast corner of brick chimney at east end of an L-shaped cabin in same yard as bench. Elevation, 25.7866.

P. B. M. 24.—See descriptions, Monroe, La., to Little Rock, Ark., p. 1468.

T. B. M. 51a.—Is nail in root of a honey locust 35 meters south of west end of freight depot at West Monroe, La. Elevation, 30.3905.

P. B. M. 25.—See descriptions, Monroe, La., to Little Rock, Ark., p. 1468.

P. B. M. 26.—See descriptions, Monroe to mouth of Black River, La., p. 1474.

P. B. M. 27.—See descriptions, Monroe, La., to Little Rock, Ark., p. 1468.

P. B. M. 28.—See descriptions, Monroe to mouth of Black River, La., p. 1474.

T. B. M. 52.—Nail in root of hickory about 20 meters north of track and 10 meters east of milepost 74 from Delta. Elevation, 29.9931.

P. B. M. 29.—Pipestone bench at northeast corner of section-house yard at Cheniere Station, Ouachita Parish, La. Bench is 17.5 meters south of center line of track and 63.7 meters east of Vicksburg, Shreveport and Pacific pile bridge 181. Elevation, 33.4937.

T. B. M. 60a.—Is X on railroad spike in root of a gum 300 meters west from milepost 84 from Delta and 25 meters south of track. Elevation, 52.4354.

P. B. M. 30.—Pipestone bench at northwest corner of yard of C. C. Harris, Calhoun, Ouachita Parish, La., 18 meters west and 7.5 meters north of northwest corner of house and 45 meters south of center of track. Elevation, 56.6262.

T. B. M. 63.—Nail in root of a Spanish oak, 25 meters north of Vicksburg, Shreveport and Pacific Railway track and 50 meters east of bridge 94. Elevation, 64.6592.

T. B. M. 64a.—Is X on spike in root of large pine 40 meters south of track and 0.4 kilometer west of milepost 89 from Delta. Elevation, 60.5893.

T. B. M. 66.—Nail in root of pine, 25 meters north of track and 45 meters northeast of Choudrant Station. Elevation, 53.1183.

P. B. M. 32.—Pipestone bench at Choudrant, Lincoln Parish, La., 1 meter east and 4.4 meters north of southeast corner of Farmers' Union office and 66 meters north of center line of track. Elevation, 52.5965.

T. B. M. 67.—Nail in root of a large white oak, 20 meters north of west end of bridge 211. Elevation, 49.6381.

T. B. M. 68.—Nail in root of a large white oak, 20 meters north of bridge 215 and 200 meters west of milepost 97 from Delta. Elevation, 52.3891.

T. B. M. 70.—Nail in root of a large pine, 30 meters north of track and 300 meters west of milepost 101 from Delta. Elevation, 82.2710.

T. B. M. 71a.—Spike in root of a pine, about 50 meters south of track and near east end of switch at Ruston, La. Elevation, 100.7533.

P. B. M. 33.—Pipestone bench in court-house yard, Ruston, Lincoln Parish, La. Bench is 1.5 meters south and 1.5 meters west of southeast corner of brick building used as sheriff's office, at southwest corner of Louisiana and Vienna streets. Elevation, 102.0297.

B. M. Ruston.—Nail in root of a pine 60 meters south of railroad track and 50 meters southwest of depot at Ruston. Elevation, 100.1016.

T. B. M. 72a. = Vicksburg, Shreveport and Pacific Railroad B. M.—Is X on steel rail 3 meters south of center of track and 60 meters west of milepost 104 from Delta. Elevation, 80.5074.

Vicksburg, Shreveport and Pacific Railway B. M.—Is X on steel rail 3 meters south of center of track and 200 meters from milepost 104 from Delta. Elevation, 79.6940.

P. B. M. 34.—Pipestone bench 50 meters northwest of platform at Allen Green Station, Lincoln Parish, La., 46 meters north of center of track, 1 meter east of frame store, and 27 meters northeast of blazed oak. Elevation, 106.8176.

T. B. M. 75.—Is nail in white oak 20 meters south of track and 150 meters east of bridge 228. Elevation, 101.7255.

T. B. M. 77.—Nail in root of a pine 25 meters north of railroad track and 110 meters west of bridge 240. Elevation, 103.8253.

P. B. M. 35.—Pipestone bench in northwest corner of yard of Mr. Madden, Simsboro, Lincoln Parish, La. Bench is 1 meter from street line, 1 meter from fence on west side of yard, and 24.5 meters from northwest corner of house. Elevation, 103.8135.

T. B. M. 80.—Nail in root of a pine about 20 meters north of track and about 100 meters east of milepost 117 from Delta. Elevation, 113.6379.

T. B. M. 81.—Nail in root of a white oak 30 meters north of track and 100 meters west of milepost 119 from Delta. Elevation, 115.5683.

P. B. M. 36.—Pipestone bench in southeast corner of section-house yard at Arcadia, Bienville Parish, La., 6.7 meters south and 6.5 meters east of the southeast corner of the most easterly of four section houses, 24 meters north of center of track. Elevation, 118.6491.

T. B. M. 82.—Nail in root of a sweet gum, 35 meters north of bridge 251, and 100 meters east of milepost 121 from Delta. Elevation, 109.2173.

T. B. M. 83a. = Vicksburg, Shreveport and Pacific Railway B. M.—Is X on rail at point of tangency of curve, 300 meters east of milepost 123 from Delta. Elevation, 86.3932.

T. B. M. 85a.—Is nail in root of a white oak, 25 meters south of track and 35 meters west of milepost 126 from Delta. Elevation, 76.2179.

T. B. M. 86.—Is nail in root of a hickory, 35 meters north of track and about 75 meters west of milepost 128 from Delta. Elevation, 73.0043.

P. B. M. 37.—Pipestone bench in northeast corner of Colbert Hotel yard, Gibbsland Station, Bienville Parish, La. Bench is 1.3 meters south and 1.4 meters west of northeast fence corner and 31.6 meters south of center of track. Elevation, 79.9252.

T. B. M. 88.—Is nail in root of a pine about 25 meters north of track and 20 meters west of platform at Taylor Station. Elevation, 74.1700.

P. B. M. 38.—Pipestone bench in northeast corner of gin yard at Taylor Station, Bienville Parish, La. Bench is 12.5 meters north and 8.3 meters east of northeast corner of gin, and 17.5 meters south of track. Elevation, 72.7106.

T. B. M. 91a. = Vicksburg, Shreveport and Pacific Railway B. M.—Is X on steel rail, 3 meters south of track and 25 meters west of bridge 294. Elevation, 88.0280.

P. B. M. 39.—Pipestone bench in southeast corner of yard of P. H. McCary, Dubberly, Webster Parish, La. Bench is 1.1 meters north and 1 meter west of fence corner and 11.8 meters from southeast corner of brick chimney at south side of house. Elevation, 84.1937.

T. B. M. 95.—Is top of large nail in root of water oak about 25 meters north of track and about 35 meters east of bridge 301. Elevation, 61.4472.

P. B. M. 40.—Pipestone bench in northwest corner of Mr. Allison's yard, Sibley, Webster Parish, La. Bench is 1.1 meters south and 0.8 meter east of fence corner, 28.8 meters south of center line of track, and 15 meters from northwest corner of house. Elevation, 63.7830.

P. B. M. 41.—Pipestone bench on east bank of Bayou Dorcheat, near Vicksburg, Shreveport and Pacific bridge. Bench is in direct range of second bent of east bridge approach, 22 meters south of center of track and 20.5 meters east of drawspan of bridge. Elevation, 49.1316.

T. B. M. 99.—Nail in root of a large pine, 20 meters north of track and 80 meters west of bridge 308. Elevation, 60.1672.

T. B. M. 101.—Nail in root of oak, 25 meters north of track and 400 meters west of milepost 147 from Delta. Elevation, 67.9026.

P. B. M. 42.—Pipestone bench in northwest corner of field owned by D. B. Doyle, at Doyle Station, Webster Parish, La. Bench is 45 meters south of Farmers' Alliance building, 30 meters southeast of southeast corner of Doyle's store, and directly southwest from station platform. Elevation, 74.2209.

T. B. M. 105.—Large nail in root of a post oak about 20 meters north of track and 400 meters west of bridge 319. Elevation, 71.2721.

T. B. M. 106.—Nail in root of a pine, 45 meters north of track and 200 meters west of Haughton Station. Elevation, 78.1534.

P. B. M. 43.—Pipestone bench in southwest corner of J. T. Edwards's yard, Haughton, Bossier Parish, La. Bench is 11.6 meters south and 10.4 meters west of southwest corner of residence. Elevation, 78.3464.

T. B. M. 108.—Nail in root of a post oak, 15 meters north of track and 300 meters west of first curve east of Bodcau. Elevation, 67.8382.

P. B. M. 44.—Pipestone bench in northeast corner of yard of Oliver Williams, Bodcau, Bossier Parish, La. Bench is 5.6 meters east and 4.5 meters north of northeast corner of residence and 24.3 meters south of center of track. Elevation 68.2739.

T. B. M. 113.—Nail in root of a hackberry, 20 meters north of track and about 90 meters west of bridge 344. Elevation, 57.0782.

T. B. M. 114.—Bench destroyed.

T. B. M. 116a.—Is X on anchor bolt on first pier at east end of railway bridge at Shreveport, La., and on south side of bridge. Elevation, 62.9511.

P. B. M. 45.—See descriptions, Camden, Ark., to Shreveport, La., p 1484.

P. B. M. 46.—See descriptions, Camden, Ark., to Shreveport, La., p. 1484.

Mark for barometer.—Is X cut in stone sill of back door of post-office in public building in Shreveport, Caddo Parish, La. Elevation, 66.8489.

Bayou Pierre B. M. 2.—Is cross cut on lower course of stone of the top stones on south side of west abutment of the Vicksburg, Shreveport and Pacific Railway bridge at Shreveport, La. Elevation, 61.5945.

Follett's B. M.—Bench destroyed.

Woodruff's B. M.—Top surface of bolt through lowest star casting north of (and 8 meters distant) east folding door of Marsh & McKellar's brick warehouse facing river. Elevation, 61.9883.

T. B. M. 121.—Is X on pipe of ◬ 148 of Red River survey. Elevation, 57.2965.

P. B. M. 47.—Pipestone bench in southwest corner of field on Kincaid place, left bank of Red River, Bossier Parish, La. Bench is 115 meters back of levee on river front, 50 meters east of bank of bayou, and 60 meters northwest from cabin standing east of bayou and back of levee. Elevation, 56.1382.

T. B. M. 123.—Nail in root of a cottonwood, 90 meters west of new levee, 200 meters east of river, and 300 meters south from Curtis post-office, La. Elevation, 56.8963.

T. B. M. 128.—Nail in root of a cottonwood near edge of river, about 40 meters above store at Lotus Landing, La. Elevation, 54.7043.

P. B. M. 48.—Pipestone bench at Lotus Landing, right bank of Red River, Caddo Parish, La. Bench is in northwest corner of yard of Captain Robson's store, 46.5 meters from river, 1.5 meters back of store, and 50 meters south of dwelling house just above the store. Elevation, 54.2303.

T. B. M. 129.—Nail in root of a pecan on river bank in front of Mr. Mercer's residence. Elevation, 54.3610.

T. B. M. 131.—Nail in root of a barren mulberry about 150 meters below gin at Ashwood Landing. Elevation, 53.8239.

P. B. M. 49.—Pipestone bench at bend in levee about 430 meters south of gin on Cash plantation, right bank of river, Caddo Parish, La. Bench is 137 meters from river, 83 meters northwest of bayou, and 3 meters north of thorn tree on outer side of levee. Elevation, 52.5988.

T. B. M. 132.—Nail in root of a honey locust at head of lane leading across Pascagoula Point. Elevation, 53.2232.

Old B. M.—Nail in east root of same tree as T. B. M. 132. Elevation, 53.4945.

P. B. M. 50.—Pipestone bench near Caspiana Landing, right bank of river, Caddo Parish, La., on J. H. Hutchinson's plantation. Bench is 2.5 meters east of gin, 126 meters from river, and 40 meters south of public road. Elevation, 51.3353.

T. B. M. 136.—Nail in root of a chinaberry, 100 meters southeast from residence of J. Allison, 10 meters north from river, and 400 meters northeast from gin. Elevation, 52.4049.

P. B. M. 51.—Pipestone bench in southeast corner of Dr. T. Allison's yard, Campo Bello plantation, Caddo Parish, La., right bank. Bench is 97 meters from river, 19 meters north and 3.9 meters east of southeast corner of house, and about 300 meters southeast of gin. Elevation, 50.8160.

T. B. M. 138.—Nail in root of a chinaberry 15 meters from gin, 20 meters from river, and about 0.8 kilometer below Bear Point Landing. Elevation, 51.8783.

T. B. M. 139.—Nail in root of small chinaberry, on road, 20 meters from river and about 0.6 kilometer below Bear Point, and at first bend of river below Bear Point. Elevation, 52.4327.

P. B. M. 52.—Pipestone bench on Bonner's plantation, Caddo Parish, La., right bank. Bench is 8 meters north and 2 meters east of cabin occupied by S. Smith (colored), 183 meters from river, and 300 meters southwest of a gin standing at first bend of river to the left below Bear Point Landing. Elevation, 50.0772.

T. B. M. 141.—Nail in root of a chinaberry 20 meters south-southwest from Cotton Point store, and 50 meters northwest from gin. Elevation, 50.9822.

P. B. M. 53.—Pipestone bench on Stringfellow's plantation, near Howard post-office, Red River Parish, La., right bank of river. Bench is in southwest corner of yard of cabin occupied by S. Johnson (colored), 23.5 meters south and 6.8 meters west of cabin. Cabin stands 300 meters southwest of plantation house and 200 meters south of gin. It is first cabin south of post-office. Elevation, 49.2729.

T. B. M. 144.—Nail in root of a pecan standing in cotton patch on Mt. Flat place, 35 meters north from road and 110 meters south from river. Elevation, 50.4900.

B. M. a.—Nail in root of chinaberry tree at mouth of Loggy Bayou. Elevation, 49.9965.

P. B. M. 54.—Pipestone bench in yard of Thomas Bell, just below mouth of Loggy Bayou, Red River Parish, La., on left bank of river. Bench is 10.4 meters north of residence and 45 meters from river bank. Elevation, 50.0054.

P. B. M. 55.—Bench destroyed.

P. B. M. 56.—Pipestone bench on Crichton's plantation, Red River Parish, La., on left bank of river. Bench is in southwest corner of yard around two cabins standing where river makes an abrupt turn to the right. Cabins are about 400 meters below Mr. Crichton's residence and 100 meters to left of public road. Elevation, 48.1637.

P. B. M. 57.—Pipestone bench in northwest corner of court-house yard at Coushatta, Red River Parish, La. Bench is 1 meter from north fence line, 1 meter from west fence line, and 33.2 meters from northwest corner of court-house. Elevation, 46.4892.

COUSHATTA TO GRAND BEND, LA.

P. B. M. 57.—See descriptions, Delta to Coushatta, La., above, on this page.

P. B. M. 58.—Pipestone bench in northwest corner of yard of Methodist church at Coushatta, Red River Parish, La. Bench is 0.8 meter from north fence line, 0.9 meter from west fence line, 31 meters from east fence line, and 7.9 meters from northwest corner of church. Elevation, 46.9133.

P. B. M. 59.—Pipestone bench at Upper Brownsville plantation, Red River Parish, La., in northeast corner of garden back of negro cabin standing about 600 meters southeast of Lake End Landing and 300 meters from bank. Bench is 10 meters southeast of southeast corner of cabin. Elevation, 44.7181.

P. B. M. 60.—Pipestone bench on property of George Johnson (colored), next below Boyce plantation, Natchitoches Parish, La., right bank. Property lies just above Old River and on left of public road to Campti. Bench is 1.8 meters from north line of residence and on line with front of gallery. Elevation, 43.1119.

P. B. M. 61.—Bench destroyed.

P. B. M. 62.—Pipestone bench in small yard adjoining Willow post-office building, Natchitoches Parish, La. Bench is 3.5 meters south of south line of post-office and 3 meters west of west line. Elevation, 42.4604.

P. B. M. 63.—Pipestone bench in southwest corner of yard of H. P. Gallion, Natchitoches Parish, La., opposite lower end of Tiger Island, and on east bank of Fausse River, just above where it branches. Bench is 39 meters west of west line of gallery of residence and 5.5 meters south of south line of residence. Elevation, 40.5616.

P. B. M. 64.—Pipestone bench at St. Maurice, Winn Parish, La., in southeast corner of inclosure southeast of E. W. Tidlie's store, 0.8 meter northwest of southwest line of front gallery and 5.2 meters southwest of southwest line of store. Elevation, 39.0050.

P. B. M. 65.—Pipestone bench on plantation of C. C. Dunn, Grant Parish, La., near a cabin standing 375 meters above Dunns Landing. Bench is 5.1 meters south of south wall of cabin and 8 meters east of east wall. Elevation, 38.1094.

P. B. M. 66.—Pipestone bench on plantation of Dr. R. E. Jackson, Natchitoches Parish, La., about 1.5 kilometers below town of Montgomery, and on right bank. Bench is in northeast corner of Dr. Jackson's yard, 31.6 meters east of east wall of house and 23.3 meters north of north wall. Elevation, 36.4126.

P. B. M. 67.—Pipestone bench on J. A. Williams's plantation, at Buxtons Landing Natchitoches Parish, La. Bench is 60 meters east of east wall of plantation house and 14 meters south of south wall. House stands 80 meters below mouth of Little River. Elevation, 34.2971.

P. B. M. 68.—Pipestone bench on right bank opposite dwelling on plantation of Isaac McMills and about 6.4 kilometers above the town of Colfax, Grant Parish, La. Bench is referenced as follows: No. 1, blazed oak southwest of bench, 6 meters; No. 2, blazed oak northwest, 11 meters; No. 3, △ 248 north, 70 meters. △ 248 is on river bank, 260 meters below mouth of small bayou. Elevation, 32.5759.

P. B. M. 69.—Pipestone bench in northwest corner of court-house yard, at southeast corner of Second and Main streets, Colfax, Grant Parish, La. Bench is 8.4 meters north of north wall of court-house and 16.2 meters west of west wall. Elevation, 35.4984.

P. B. M. 70.—Pipestone bench on plantation of Mrs. A. C. Deal, Grant Parish, La., about 2 kilometers above Fairmount post-office and opposite Deloaches Rock. Bench is in southeast corner of yard on west side of Mrs. Deal's store, 5 meters south of south wall of store and 9.4 meters west of east wall. Elevation, 35.0013.

P. B. M. 71.—Pipestone bench at Boyce, Rapides Parish, La., next to fence in field belonging to Mr. Boyce and at angle of lane running back from warehouse along northwest side of town. Bench is 42 meters northwest of southeast (or front) wall prolonged of J. T. Cranahan's residence and 37.1 meters northeast of northeast wall prolonged. Elevation, 32.3477.

P. B. M. 72.—Pipestone bench on Mr. Marye's plantation, Rapides Parish, La., about 5.6 kilometers below Rapides post-office. Bench is on a small levee 0.7 meter northwest of intersection of levee with division fence between Marye's and Cruikshank's plantations, and 4 meters southeast of angle in levee where it changes its course from south by west to east-northeast. Elevation, 30.0909.

P. B. M. 73.—Pipestone bench in south corner of court-house yard, corner of Lee and Second streets, Alexandria, Rapides Parish, La. Bench is 26.7 meters southwest of southwest wall of court-house and 21.3 meters southeast of south wall. Elevation, 28.6423.

P. B. M. 74.—Pipestone bench in east corner of yard of Rapides Parish jail, Alexandria, La., on Lee street, between Fifth and Sixth streets. Bench is 3.2 meters southeast of southeast wall of jail and 10 meters northeast of northeast wall. Elevation, 27.7949.

T. B. M. 86=B. M. 1 (*Merrill, 1871*).—Bench destroyed.

B. M. 3 (*Merrill, 1871*).—On top projecting layer of brick on east corner of court-house, Alexandria, La. Elevation, 30.4752.

B. M. 4 (*Merrill, 1871*).—Top surface of lower iron plate of iron pedestal of southeast pillar of vestibule of river entrance of court-house, Alexandria, La. Elevation, 30.2130.

P. B. M. 75.—Pipestone bench on plantation of C. O. Harris, Rapides Parish, La., right bank about 8 kilometers below Alexandria, La., and near a cabin standing 32 meters west of a point on levee, which is 22.5 meters below bend in levee opposite and a little above Cannon's wood yard. Bench is 6.3 meters north of north wall of cabin, 17.2 meters east of east wall, and 16 meters back of levee. Elevation, 28.2738.

P. B. M. 76.—Pipestone bench same as △ southwest base of Grand Bend base line, and is on Peart's plantation, Rapides Parish, La., on neck of Grand Bend. Bench is about midway on neck at side of fence dividing pasture and thicket, on thicket side. Elevation, 27.8462.

GRAND BEND TO SMITHLAND, LA.

P. B. M. 76.—See descriptions, Coushatta to Grand Bend, La., above, on this page.

T. B. M. 2.—Spike in root of a large white oak on Peart's place, 5 meters from levee and 125 meters north of Peart's residence. Elevation, 28.4373.

T. B. M. 3.—Spike in root of a pecan 10 meters inside of levee, on road back of Rogers Landing and 100 meters from dwelling. Elevation, 27.6415.

T. B. M. 4.—Spike in small chinaberry on county road, 250 meters northwest of church and 10 meters inside of levee on Mary Hotchier's place. Elevation, 27.5646.

T. B. M. 5.—Spike in root of a big oak in front of Wm. Wilson's house and 10 meters back of levee. Elevation, 27.5306.

P. B. M. 77.—Pipestone bench near Jones Quarter Landing, Rapides Parish, La. It is about 300 meters below the landing, 10 meters south of parish road, 12 meters from base of State levee, and 81 meters back from bank of river. On property of Frank White, 1 meter from division line of Polyte Smith. Elevation, 26.3879.

T. B. M. 7.—Spike in root of a pine in old field, 25 meters from levee and 300 meters north from Bob Hathorn's house. Elevation, 27.2627.

T. B. M. 8.—Spike in root of a small box elder on inside slope of levee, on parish road, and 100 meters north of cabin, occupied by James Price, on Bob Hathorn's place. Elevation, 27.5931.

T. B. M. 9.—Spike in root of a large pecan on James Wilson's place, 25 meters from levee and 100 meters from junction of old and new levees. Elevation, 26.6263.

T. B. M. 10.—Spike in root of a small locust, 800 meters southeast of Dorman's gin and at bend in levee. Elevation, 26.7125.

T. B. M. 11.—Spike in root of a 14-inch pecan in cotton field, about 40 meters from levee and 500 meters southeast from church below Ben Lewis's place. Elevation, 26.7479.

T. B. M. 13.—Spike in root of a 1½-foot cottonwood on parish road, 10 meters from inside of levee and 100 meters south from schoolhouse on Rogers's place. Elevation, 25.7768.

T. B. M. 14.—Spike in root of a 2-foot cottonwood in an old field, 15 meters from levee and 300 meters southeast from house on Dupee place. Elevation, 26.1733.

P. B. M. 78.—Pipestone bench, about 3.1 kilometers below Poland post-office, at Once More Landing, Rapides Parish, La. It is situated in lower rear fence corner of George Wilson's horse lot. Elevation, 24.7275.

T. B. M. 19.—Spike in root of a 1-foot sycamore on parish road, 10 meters from levee, 90 meters south from cabin on George Wilson's place. Elevation, 25.7105.

T. B. M. 20.—Spike in root of a small pecan on parish road at foot of levee and in front of Mr. Foster's house on Foster's place. Elevation, 25.5885.

T. B. M. 23 = ◬ *362.*—Nail in top of jar on James Adams's place, 4 meters from road and 48 meters from levee. Elevation, 25.5467.

T. B. M. 24.—Spike in root of a 1½-foot sycamore, 10 meters from levee on parish road and in front of deserted cabin about 740 meters below ◬ 362. Elevation, 25.2162.

T. B. M. 26.—Spike in root of a 1-foot locust at foot of levee, opposite store at Egg Bend Landing, La. Elevation, 25.4317.

P. B. M. 79.—Destroyed.

T. B. M. 28.—Spike in root of a 1-foot hackberry on main road, 5 meters from levee and 100 meters above Mrs. Bringo's cabin. Elevation, 25.7039.

T. B. M. 31.—Spike in root of a 1-foot hog haw, 10 meters from levee and 2 meters from small cotton house on Octave Larsny place, and 250 meters above house. Elevation, 25.5771.

T. B. M. 32.—Spike in root of a 2-foot cottonwood on side of road, 5 meters from levee and in front of E. B. Norman's house. Elevation, 25.5353.

T. B. M. 35.—Spike in root of a 2-foot willow on left bank of Choctaw Bayou and right bank of river and 50 meters below house. Elevation, 25.4481.

T. B. M. 36.—Spike in root of a 2-foot cottonwood, about 81 meters below bank of Choctaw Bayou and 25 meters from right bank of Red River. Elevation, 25.5313.

P. B. M. 80.—David Ferry, Avoyelles Parish, La. Is horizontal cut in hemispherical head of copper bolt leaded horizontally into seventeenth course of brick above the footing, near the middle of the northwest face of chimney at southwest end of house occupied by Laborde. The letters $\overset{\text{U S}}{\underset{\text{B M}}{\ominus}}$ are cut into the brick. House is on right bank of Red River, about 400 meters above road to Marksville, La. Elevation, 26.4061.

T. B. M. 42.—Spike in root of an 8-inch elm on side of road 15 meters from right bank of river, and 250 meters below Laborde Landing, and opposite big two-story building on left bank. Elevation, 24.7102.

T. B. M. 43.—Spike in root of a 2½-foot cottonwood on side of road inside of levee about 100 meters from right bank of river and 293 meters above L. Saucier's gin. Elevation, 24.7398.

T. B. M. 48.—Spike in root of a 1-foot sycamore about 10 meters from river and 700 meters above Normands Landing. Elevation, 24.1738.

T. B. M. 49.—Spike in a 4-foot cottonwood 50 meters from river, on Reynaud place, and 100 meters above Normands Landing. Elevation, 23.5921.

P. B. M. 81.—Is center of horizontal cut in head of copper bolt leaded horizontally into sixteenth course of brick above footing, near middle of south face of chimney at south end of house occupied by R. L. Reynaud, on right bank of Red River. Letters B $\ominus$ M are cut in brick. Elevation, 24.9366.

P. B. M. 82.—Normands Landing, Avoyelles Parish, La. Is center of horizontal cut in head of copper bolt leaded horizontally into twelfth course of brick above footing, near middle of east face of chimney at east side of house occupied by William Van Osdell and owned by R. L. Reynaud. Letters $\overset{\text{B M}}{\ominus}$ cut in brick. Elevation, 25.0181.

T. B. M. 51.—Spike in root of a 4-foot pin oak on east side of road from Normands Landing to Marksville and 50 meters south of Ribouche's house. Elevation, 29.6656.

T. B. M. 51a.—Spike in root of a 2.5-foot cottonwood at Barbin Landing, 50 meters from bank of river and 20 meters west of warehouse. Elevation, 23.5529.

T. B. M. 52.—Spike in root of a 4-foot pin oak on west side of road from Barbin Landing to Marksville on Grumpier place and 250 meters north of Bize's gin. Elevation, 29.8679.

T. B. M. 53.—Spike in root of a 3-foot pin oak, on Marksville-Barbin Landing road, and in front of Mrs. Famies's house. Elevation, 30.3598.

T. B. M. 55.—Spike in root of an 8-inch chinaberry in front of Dr. Mix's residence in north end of Marksville. Elevation, 31.0448.

P. B. M. 83.—Marksville, Avoyelles Parish, La. Horizontal cut in head of copper bolt leaded horizontally into eighteenth course of brick above ground, about the middle of the east (Washington street) side of parish court-house. It is between the east door and the window near front side. Marked $\overset{\text{U S}}{\underset{\text{B M}}{\ominus}}$. United States Signal Office is east of court-house. Elevation, 32.8562.

T. B. M. 58.—Spike in root of an 18-inch black locust, 30 meters southeast of Avnes Collar's dwelling at Cocoville. Elevation, 28.2922.

T. B. M. 62.—Nail in root of a chinaberry, on east side of road, in front of David Siess's residence at Mansura, La. Elevation, 29.0662.

P. B. M. 84.—Mansura, Avoyelles Parish, La. Is horizontal cut in head of copper bolt leaded horizontally in northwest pier of gallery of unoccupied store owned by David Siess, on east side of road. Store is about 30 meters south-southwest of David Siess's dwelling and about 85 meters southeast of F. Regard's store. Marked, B. $\ominus$ M. Elevation, 29.4752.

P. B. M. 85.—Near southern limits of Mansura, Avoyelles Parish, La. Is horizontal cut in head of copper bolt leaded horizontally into nineteenth course of brick above ground, on south side of chimney at west end of Mme. Victor Claude's residence on north side of road leading to Moreauville. Marked $\overset{\text{U S}}{\underset{\text{B M}}{\ominus}}$. Elevation, 30.4699.

T. B. M. 64.—Spike in root of a 3-foot sweet gum, 25 meters west of cabin, on west side of road and on edge of first unfenced grove south of Mansura. Elevation, 31.0376.

T. B. M. 64a.—Spike in root of a 4-foot blazed pecan, 50 meters northeast of road, and on southeast bank of Cypress Bayou. Road runs northeast of and parallel to Long Bridge. Elevation, 21.6258.

T. B. M. 66.—Spike in root of an 18-inch chinaberry tree, on left bank of Bayou des Glaises, in front of L. D. Tassin's dwelling. Elevation, 23.5336.

T. B. M. 67.—Spike in root of a 15-inch locust, on left bank of Bayou des Glaises, 35 meters from Tony Lien's dwelling, and about 1.2 kilometers above Lemoines Ferry. Elevation, 22.6283.

T. B. M. 68.—Nail in root of a 15-inch chinaberry on left bank of Bayou des Glaises and 35 meters above Lemoines Ferry. Elevation, 23.4204.

T. B. M. 69.—Spike in root of an 8-inch cherry tree in front of Dr. Rabelais's dwelling on right bank of Bayou des Glaises and a little west of Moreauville. Elevation, 23.5102.

P. B. M. 86.—Moreauville, Avoyelles Parish, La. Horizontal cut in head of copper bolt leaded horizontally into twenty-second course of brick above ground of chimney on east side of cabin occupied by Edmond Baker (colored), on Dr. Rabelais's plantation. Cabin is about 30 meters south of right bank of Bayou des Glaises and about 1,000 meters west of where Hamburg road leaves the bank of bayou. Marked $\overset{\text{B M}}{\ominus}$. Elevation, 24.8523.

T. B. M. 70.—Spike in root of a 2-foot chinaberry at corner where road turns east going to Hamburg. Tree is 45 meters southwest of Moreauville post-office. Elevation, 23.5198.

T. B. M. 72.—Spike in root of a 3-foot blazed gum, on north side of road and 1,819 meters west of Hamburg. Elevation, 19.9220.

T. B. M. 73.—Spike in root of a 2-inch sycamore on south side of road and 500 meters west of Hamburg. Elevation, 21.2821.

P. B. M. 87.—About 445 meters southeast of Hamburg, Avoyelles Parish, La. Is center of copper bolt leaded horizontally into twenty-first course of brick above ground in chimney on west side of cabin occupied by Bazil Francois, on F. M. Pavey's plantation. Cabin is situated about 60 meters from right bank of Bayou des Glaises. Marked B $\oplus$ M. Elevation, 23.1575.

T. B. M. 74.—Spike in root of a 2.5-foot pecan, 75 meters northwest of house occupied by Bordelon, on F. M. Pavey's place. Elevation, 21.8785.

T. B. M. 75.—Spike in root of a 3-foot sycamore, 25 meters southwest of cabin occupied by Abraham Isham, on Fred Griflin's place. Elevation, 21.3934.

T. B. M. 80.—Spike in root of a 2.5-foot sycamore, about 50 meters north of cabin occupied by Philip Banks, on William Perkins's place, about 1.5 kilometers below Red Fish post-office. Elevation, 21.1320.

T. B. M. 81.—Spike in root of a 1-foot hackberry, in front of cabin occupied by Peter Williams, on Tom Densoris's place. Elevation, 20.6811.

T. B. M. 82.—Spike in root of a 1-foot gum, about 70 meters northwest of cabin occupied by Mary Geiss, on A. C. Simmons's place. Elevation, 20.6460.

T. B. M. 83.—Spike in root of a 2-foot pecan in yard adjoining cabin occupied by W. B. Jones, on H. M. Norwood's place. Elevation, 20.6718.

P. B. M. 88.—About 2.4 kilometers, measured along road, west of Simmesport, Avoyelles Parish, La. Is center of cross in head of copper bolt leaded horizontally into thirteenth course of brick above ground of chimney of cabin occupied by W. B. Jones (colored), on H. N. Norwood's plantation. Cabin is on right bank of Bayou des Glaises and on Atchafalaya road, about 175 meters east of Harlands (also called Hollands) Bayou. Marked B ○ M. Elevation, 21.5785.

T. B. M. 84.—Spike in root of a 3.5-foot oak, 30 meters northwest of cabin at angle of main road turning south to Simmesport, on Sam Norwood's place. Elevation, 20.4766.

T. B. M. 85=Old B. M. 4.—Spike in root of a 2-foot sycamore at northeast corner of N. Norwood's store at Simmesport, La. Elevation, 20.3055.

P. B. M. 89.—Pipestone bench at Simmesport, Avoyelles Parish, La. Is in northeast corner of J. Trudeau's front yard and just south of N. Norwood's store. Elevation, 18.9715.

T. B. M. 86.—Spike in root of an 18-inch bois d'arc on left bank of river and 256 meters north of Legonier post-office. Elevation, 20.9518.

Wilson's B. M. 4.—Wrought-iron spike in root of a 4-foot cottonwood, 6.5 meters west of center of levee and 388 meters south of Legonier post-office. Elevation, 20.5958.

T. B. M. 87.—Spike in root of a 3.5-foot pin oak, about 30 meters southeast of bayou and 200 meters southwest of A. J. Norwood's residence. Elevation, 20.7956.

T. B. M. 89.—Spike in root of a 2-foot sycamore, on east side of road and about 59 meters south of cabin occupied by Maria Pete on Sam Stribling's place. Elevation, 21.0546.

T. B. M. 91.—Spike in root of a 2.5-foot hackberry, in front of Capt. D. T. Merrick's residence. Elevation, 21.2591.

T. B. M. 92.—Spike in root of an 18-inch locust, 75 meters northwest of house on Capt. D. T. Merrick's place. Elevation, 21.4539.

P. B. M. 90.—Pipestone bench on Tom Carruth's plantation, near Water Valley Landing, Avoyelles Parish, La. Is 25 meters east of woodline fence, 338 meters west of cabin occupied by William Fields (colored), and 375 meters west of cabin occupied by M. Laborde. Witnessed by three blazed trees, as follows: First, 1 meter diameter, 66° 30′, 8 meters; second, 0.6 meter diameter, 328° 40′, 23 meters; third, 0.6 meter diameter, 271° 25′, 11 meters; all on right bank of Old River and right bank of Atchafalaya River. Elevation, 19.2001.

P. B. M. 91.—Pipestone bench near Merrick post-office, Pointe Coupée Parish, La. Is at corner of fence around cabin occupied by Sam Morris, on D. T. Merrick's plantation, and 285 meters south of levee. Elevation, 19.7654.

T. B. M. 94.—Spike in root of a 2-foot pecan about 15 meters west of hedge, by side of lane dividing property of George Keller and S. Barbre. Is on S. Barbre's place and 75 meters south of levee. Elevation, 21.3921.

P. B. M. 92.—Pipestone bench near Barbre Landing, Pointe Coupée Parish, La., on S. Barbre's plantation, on west side of hedge on west side of lane dividing S. Barbre's and George Keller's plantations. It is about 125 meters south of levee and 99 meters southeast of cabin occupied by Kate Watson (colored), and 273 meters south of S. Barbre's residence. Elevation, 19.8466.

P. B. M. 93.—About 780 meters (measured along road) southeast of Barbre Landing, Pointe Coupée Parish, La. Is top of copper bolt cemented in top of marble post (15 by 15 centimeters) about 13 meters from levee, in corner of fence. Marked $\overset{\text{U S}}{\underset{\text{N O}}{\odot}}$ Elevation, 21.3510.

P. B. M. 94.—About 1,275 meters (measured along road) southeast of Barbre Landing, Pointe Coupée Parish, La. Is top of copper bolt cemented in top of marble post (15 by 15 centimeters). Is in front of George Keller's plantation, at corner of fence and 13 meters from levee. Marked $\overset{\text{U S}}{\underset{\text{N O}}{\odot}}$ Elevation, 21.5514.

T. B. M. 95.—Spike in root of a 4½-foot pin oak, in front of J. P. Chandler's place, and 600 meters southeast of his residence. Elevation, 21.3542.

T. B. M. 96.—Spike in root of a 1-foot elm, in churchyard, about 5 meters southeast of Negro Methodist Church on Chandler's place. Elevation, 21.1468.

T. B. M. 97.—Spike in root of a 2-foot hackberry, between fence and levee, 655 meters (along road) northwest of Ferguson's gin. Elevation, 21.5347.

T. B. M. 98.—Spike in root of a 2-foot pecan, 10 meters west of lane dividing Ferguson and Torras places. Elevation, 21.4217.

M. R. C. B. M. $\frac{142}{3}$.—Near Torras Landing, Pointe Coupée Parish, La. Is center of top of limestone post (15 by 15 centimeters), at angle in levee at end of lane on north side of Joseph Torras's residence, and 165 meters south of Catholic church, marked $\boxed{\text{U. S.}}$. Elevation, 22.1281.

T. B. M. 99.—Spike in root of a 2-foot twin locust, about 4 meters from edge of bank, and 544 meters south of Torras Landing. Elevation, 20.1534.

T. B. M. 101.—Spike in root of an 8-inch hackberry on edge of bank, and 1,488 meters southwest of Smithland. Elevation, 20.2168.

M. R. C. B. M. $\frac{150}{4}$.—Is a pipestone bench, on side of hedge on main road by side of levee, 1,100 meters south of Smithland, and 110 meters south of house occupied by Simon Smith on George Bienvenue's place. Elevation, 20.3727.

C. and G. S. B. M. XLV.—At Smithland, Pointe Coupée Parish, La. A granite post at northwest corner of W. T. Coyle's residence. Coast and Geodetic Survey elevation, 14.7917 meters, Gulf level. Mississippi River Commission elevation, 14.8234 meters, Gulf level. Elevation, 21.0048.

DELTA, LA., TO GREENVILLE, MISS., VIA YAZOO CITY AND GREENWOOD, MISS.

C. and G. S. △ S. W. base.—See descriptions, Delta to Coushatta, La., p. 1491.

T. B. M. 4.—Is X in top of railroad spike in root toward track of a 1.5-meter cottonwood, about 100 meters east of track near roundhouse at Delta, La. Elevation, 33.8527.

C. and G. S. △ N. E. base.—The bottom of a square cut in the top of a 14 by 14 inch limestone post marking the north end of the Delta base line. The stone stands in the field 45 meters south of switch of the Vicksburg, Shreveport and Pacific Railway above the incline landing to the transfer crossing on the Louisiana bank. The stone is firmly fixed in position, but its top is about 0.2 meter below the surface of the ground (November, 1896). The copper bolt has been disturbed, and the square cut is 0.01 meter north of the copper bolt. Coast and Geodetic Survey elevation, 27.8579 meters, Gulf level. Elevation, 34.0715.

M. R. C. B. M. $\frac{107}{1}$.—A stone-line bench mark of the Mississippi River Commission. Is top of copper bolt leaded in a 6 by 6 inch granite post at Kleinston, Miss. It is 110 meters from river bank on north side of road along a line of broken levee extending back to high ground. It is 1,565 meters above oil mill and 1,178 meters below old compress, 30 meters east of the incline to the Delta transfer boat. Elevation, 33.0371.

C. and G. S. B. M. B.—The intersection of a cross in the end of a copper bolt leaded in the north end of the brick pumping station of the Vicksburg waterworks. The building is on the left bank of the river, under the hills, and about 1.6 kilometers south of the city limits of Vicksburg, Miss. The bolt is in the first course above the water table and in the third brick from the northwest corner of the building. Coast and Geodetic Survey elevation, 29.9569 meters, Gulf level. Elevation, 36.1865.

P. B. M. A. and V.—Is middle of + cut in head of copper bolt leaded horizontally into brick at southeast corner of the Alabama and Vicksburg freight depot at Vicksburg, Warren County, Miss., on corner of Washington and Depot streets. The bolt is in the seventh course above gravel pavement and in the second brick from the southeast corner of building. Elevation, 66.3323.

C. and G. S. B. M. C.—A marble post buried 1.2 meters in the ground in the southwest corner of the park west of the Alabama and Vicksburg Railway passenger station at Vicksburg, Miss. The stone is dressed on top to 0.25 by 0.175 meter, and the bottom of a square cut in the top at its center, 0.009 meter deep, is the bench mark. The top projects 0.25 meter above the surface of the ground, and is lettered as follows:
U S
C & □ G S. Coast and Geodetic Survey elevation, 62.7048 meters, Gulf level. Eleva-
B M
tion, 68.9205.

P. B. M. D.—Pipe-flange bench in the railroad yard in front of the passenger station of the Alabama and Vicksburg Railway at Vicksburg, Miss. It is about 1.2 meters south of base of the vertical face of the deep cut forming the north line of the yard. A cross cut on the permanent cap of the pipe at its north edge is the bench mark. Coast and Geodetic Survey elevation, 60.2068 meters, Gulf level. Elevation, 66.4353.

P. B. M. E.—Pipe-flange bench just inside the right-of-way fence of the Alabama and Vicksburg Railway, about 100 meters east of first overhead bridge (dirt road over railroad), about 2 kilometers east of Vicksburg, Miss. The bench is south of the track, near the fence, and on the slope leading out of the first depression east of said bridge, 6 meters west of second telegraph pole east of bridge. A cross cut in the head of the permanent cap at its north edge is the bench mark. Coast and Geodetic Survey elevation, 75.8969 meters, Gulf level. Elevation, 82.1299.

P. B. M. F.—Pipe-flange bench just inside of the right-of-way fence of the Alabama and Vicksburg Railway, about 3 kilometers east of Vicksburg, Miss. Bench mark is 10 meters west of fourth telegraph pole west of second overhead road bridge east of Vicksburg, on south side of track. The top of the cap on the pipe is divided into four sections by lines cut into it intersecting at the center. The surface of the cap at the inner corner of the southwest quarter was used as the bench mark. Coast and Geodetic Survey elevation 80.0639 meters, Gulf level. Elevation, 86.2898.

P. B. M. Tappan.—An X cut on the stone water table, so that a rod will just sit in the angle of the window and wall, at east side of east window on south (front) side of house at northwest corner of Cherry and Jackson streets, Vicksburg, Warren County, Miss. House belongs to Mrs. Tappan. Elevation, 106.5085.

B. M. East Gate.—Is + on south side of east gate to the National cemetery at Vicksburg, Miss. Elevation, 71.6909.

P. B. M. 1.—At Vicksburg, Warren County, Miss. Is cross cut in stone on east side of the gate to the National cemetery (west entrance). Stone was placed to hold gate when open. Elevation, 37.5819.

P. B. M. 2.—Pipestone bench on east side of public road, about 3 kilometers above Vicksburg, Warren County, Miss., by W. H. Hundermark's store, 2.6 meters from northwest corner of yard, and 16.4 meters from southwest corner, and 31.92 meters from center of Yazoo and Mississippi Valley Railroad track on approximate perpendicular to same. Elevation, 35.6539.

T. B. M. 1.—Wire nail in root of a 0.5-meter cottonwood on south side of road leading from the fair grounds along Lake Centennial to Allen place, and 300 meters west of a bayou. The letters U S are cut on tree above bench. Elevation, 30.6902.

T. B. M. 2.—Small wire nail in root of a 0.3-meter willow standing alone on the north side of the road along the shore of Lake Centennial, about 500 meters east of Yazoo River diversion canal right of way. The letters U S are cut on tree above bench. Elevation, 31.6442.

T. B. M. 3.—Large nail in root of a 0.5-meter leaning pecan standing 30 meters east of line of jars of Yazoo River diversion canal and opposite jar 137. Elevation, 31.2507.

T. B. M. 4.—Nail in root of a 1-meter water oak standing 1 meter east of line of jars on Yazoo River diversion canal and opposite station 155 + 25. Elevation, 31.6316.

T. B. M. 5.—Wire nail in root of a 0.5-meter pecan standing 5 meters east of line of jars on Yazoo River diversion canal and 40 meters north of jar 174. The tree has the letters U S cut on it above bench. Elevation, 31.5165.

T. B. M. 6.—Nail in root of an 0.8-meter sweet gum, standing on line of jars on Yazoo River diversion canal, 2 meters north of jar 193. Elevation, 34.1677.

T. B. M. 7.—Nail in root of a 0.5-meter scrub water oak, on front, and 20 meters above first cabin above head of Yazoo River diversion canal, and on top of bank of Old River. Elevation, 34.6454.

T. B. M. 8.—Nail in root of a 1-meter sweet gum, 30 meters south of cabin occupied by Tom Anderson, on Alf. Wilson's place. Tree is 20 meters from road and 8 meters south of a large sycamore. Elevation, 34.1784.

T. B. M. 9.—Nail in root of an 0.8-meter sweet gum 30 meters northeast of schoolhouse and 50 meters from east bank of old river. Elevation, 34.0951.

T. B. M. 10.—Nail in root of a 2-meter sweet gum on bank of Old River, 20 meters north of cabin occupied by Howard Jackson, on Manuel Sweet's place. Elevation, 34.2250.

T. B. M. 11.—Is X on head of 20-penny nail in south chimney of Manuel Sweet's residence. Nail is 0.4 meter above ground. House stands at the junction of Yazoo and Old rivers. Elevation, 35.3566.

T. B. M. 12.—Nail in root of a 1-meter cottonwood in front of church on Willis place. Elevation, 34.9051.

P. B. M. 6.—Pipestone bench on left bank of Yazoo River, almost opposite the mouth of Steele Bayou, in northeast corner of yard to residence on the Belle Isle place. Elevation, 34.6112.

P. B. M. 3.—Top of head of large spike driven in north side of brick smokestack of gin on Blakely plantation, Warren County, Miss., about 5 centimeters from ground. Elevation, 40.6444.

P. B. M. 4.—Is in northwest corner of cabin yard on left bank of Yazoo River, in Warren County, Miss., about 130 meters southwest of south end of Yazoo and Mississippi Valley Railroad bridge, and 20 meters from top of river bank. Elevation, 34.9265.

P. B. M. 5.—Is cross cut and marked U S B M on capstone of south end pier on west side of Yazoo and Mississippi Valley Railroad bridge over Yazoo River near Redwood, Miss. Elevation, 38.3497.

T. B. M. 1.—Nail in root of a 0.4-meter hackberry, on right bank of Yazoo River and 40 meters above Yazoo and Mississippi Valley Railroad drawbridge. Elevation, 35.0150.

T. B. M. 4.—Nail in root of an 0.8-meter pecan, 10 meters south of cabin on Katzmeyer's place, by side of fence on right bank of Yazoo River about 1 kilometer above Buck Ross Landing. Elevation, 34.3101.

T. B. M. 5.—Spike in root of a 0.5-meter oak, in middle of pig pen, about 60 meters east of Maggie Jessup's cabin on Katzmeyer place, 150 meters from right bank of river and opposite Haynes Bluff. Elevation, 34.7714.

T. B. M. 8.—Is X in head of drift bolt at beginning of ironwork at northwest side and southwest end of bridge over Ball Ground Creek. Is 20 meters north of Ball Ground plantation store and 150 meters northwest of dwelling. Elevation, 41.8224.

T. B. M. 9.—Spike in root of a 1.5-meter cottonwood at east end of bridge on main road over Cornhill Creek, about 2.5 kilometers south of Calmar post-office and store at Adams Landing. Elevation, 39.4396.

T. B. M. 10.—Spike in root of a 0.3-meter oak on main road, 0.6 kilometer south of Calmar post-office, 150 meters northeast of cabin occupied by Andrew Henderson on Tom Bruce's place. Elevation, 38.1842.

P. B. M. 7.—Pipestone bench at Calmar post-office, Warren County, Miss., in southeast corner of garden attached to and on north side of post-office, which is in store owned by D. M. Legg, and about 1 kilometer southeast of Adams Landing, on Yazoo River. Elevation, 37.2655.

T. B. M. 12.—Spike in root of a triplet gum, each prong 0.3 meter diameter, on east side of main road, and about 500 meters southwest of cabin occupied by Henry Holmes. Elevation, 36.0631.

T. B. M. 16.—Spike in root of a 0.5-meter oak about 50 meters above ford across Collins Bayou on road from Legg's gin to Kettleman's place. Elevation, 30.5122.

T. B. M. 21.—Spike in root of a 0.3-meter hickory on road from Kettleman's place to Kinsell post-office. Bench is about 100 meters from bank of Yazoo River and 200 meters north of fence at north end of place. Elevation, 34.5587.

T. B. M. 24a.—Spike in root of a honey locust on left bank of Yazoo River and 80 meters west of mouth of Sunflower River. Elevation, 34.5877.

P. B. M. 8.—Pipestone bench in Yazoo County, Miss., opposite L'Argent, 70 meters from left bank of Yazoo River, in the west corner of calf lot across the public road from and belonging to cabin on Indian mound, which is opposite the mouth of Big Sunflower River and on Gilruth's plantation. Elevation, 35.0270.

P. B. M. 9.—Pipestone bench at L'Argent, Sharkey County, Miss., in the southeast corner of cotton lot adjoining landing warehouse and about 25 meters from right top bank of Yazoo River. It is about 15 meters southwest of L'Argent store and 50 meters southeast of gin. Elevation, 33.0855.

T. B. M. 25.—Spike in root of a 0.3-meter gum, 10 meters from left bank of Yazoo River, about 150 meters east of bridge over bayou and 700 meters east of mouth of Big Sunflower River. Elevation, 35.1528.

T. B. M. 27.—Spike in root of a 1.5-meter water oak, 25 meters east of Lake Dick store. Elevation, 36.2004.

T. B. M. 28.—Nail in root of a 0.3-meter pecan by side of fence about 500 meters northwest of gin on Hardtimes place and 1.6 kilometers above Lake Dick store. Elevation, 35.7036.

T. B. M. 58.—Nail in root of a 0.4-meter oak on river side of road in front of cabin occupied by Zach Lassiter on Munchen Slough place and about 100 meters above bridge over the slough. Elevation, 35.3330.

T. B. M. 55.—Nail in root of a 0.4-meter chinaberry in front of cabin occupied by Ezekiel Sutton on C. O. Willis's Avondale place. Bench about 400 meters above plantation residence. Elevation, 37.2127.

P. B M. 10.—Pipestone bench at Satartia, Yazoo County, Miss., in the northeast corner of yard of Union church and Masonic lodge (Satartia Lodge, No. 176), at corner of Plum and Perry streets. Elevation, 35.8602.

T. B. M. 52.—Nail in root of an 0.8-meter catalpa, about 150 meters east of John Gale's residence near Satartia, and in front of barn. Elevation, 36.1666.

T. B. M. 51.—Nail in root of a 1-meter gum on river side of road, about 75 meters east of Mingo Roe's cabin on Holly Bend place, owned by H. L. Taylor. Is on right bank of river and 1.7 kilometers above Satartia. Elevation, 36.3340.

T. B. M. 47.—Nail in root of a 0.4-meter oak on river side of road, about 75 meters below cabin occupied by Sam Johnson on Sam Brayton's Dixie place. Bench is about 150 meters above gin. Elevation, 37.3609.

T. M. B. 45.—Nail in root of a 0.5-meter gum in front of J. F. Powell's store at Enola, Miss. Elevation, 37.3810.

P. B. M. 11.—Pipestone bench at Enola, Yazoo County, Miss., in the northeast corner of yard of R. D. Saunder's dwelling, about 8 meters south of J. F. Powell's store and about 30 meters north of J. D. Saunder's store. Elevation, 36.5160.

T. B. M. 43.—Nail in root of a 0.3-meter bois d'arc on river side of road, about 75 meters above gin on Dr. Wilson's Gaudyclue place. Elevation, 36.8451.

T. B. M. 42.—Nail in root of a 0.6-meter sycamore on river side of road, in front of Albert Davis's cabin, on Oak Valley place. Bench is about 150 meters above schoolhouse. Elevation, 37.0192.

T. B. M. 41.—Nail in root of a 1-meter pecan about 100 meters below Mr. Cheatem's Oak Valley gin. Bench is just inside of fence. Elevation, 36.1160.

T. B. M. 40.—Nail in root of a 1.5-meter oak about 75 meters above Jim McMeister's dwelling, on Tarsas place. Bench is on river side of road. Elevation, 37.2438.

T. B. M. 39.—Nail in root of an 0.8-meter pecan on side of road, next to fence in front of John Newberry's Willowdale place. Bench is about 100 meters above Newberry's house, and tree has sign reading, "Yazoo City, 8 miles." Elevation, 36.7821.

T. B. M. 38.—Nail in root of a 0.5-meter gum about halfway between water surface in river and road in front of R. D. Saunder's Rialto place and about 100 meters above cabin occupied by Amos Jordan. Elevation, 36.1114.

T. B. M. 37.—Nail in northwest root of a 0.6-meter honey locust on river side of main road, in front of R. D. Saunder's Rialto place and 300 meters south of plantation dwelling. Elevation, 36.9223.

T. B. M. 35.—Spike in root of a 1-meter oak on south side of main road, just inside of fence, directly in front of a cabin on P. R. Saunder's Wilton place and 1.2 kilometers west of plantation store. Elevation, 37.1468.

T. B. M. 34.—Nail in southeast root of a 1-meter oak in front of store and next to Wilton place residence, owned by P. R. Saunders, of Yazoo City. Elevation, 36.7331.

T. B. M. 33.—Nail in root of an 0.8-meter gum on right bank of Yazoo River, in front of Mrs. McCoy's Longwood place and 100 meters southwest of cabin of William Washington. Elevation, 37.0765.

T. B. M. 32.—Nail in root of a 0.7-meter elm at western end of Wilsonia. It is on edge of road, about half way across neck, and 10 meters south of Allen Jones's house. Elevation, 38.4601.

T. B. M. 31.—Nail in root of a 1.5-meter oak near left water edge of Yazoo River, about 100 meters below bridge across river and in front of William Hammil's sawmill. Elevation, 34.4002.

P. B. M. 12.—Pipestone bench at Yazoo City, Yazoo County, Miss., in the north corner of yard to county court-house. Elevation, 41.9883.

P. B. M. 13.—Pipestone bench at Yazoo City, Yazoo County, Miss., in the north corner of yard of the city public-school building. School is near intersection of Washington and Main streets. Elevation, 37.4458.

T. B. M. 208.—Nail in root of a 0.7-meter cottonwood, 25 meters east of track and 300 meters north of mile post 46 from Jackson. Elevation, 39.3041.

P. B. M. 29.—Pipestone bench at Bee Lake, Holmes County, Miss., at north corner of Illinois Central Railroad depot. Elevation, 39.0518.

T. B. M. 188.—Nail in root of a 0.7-meter gum 30 meters west of track and 25 meters west of milepost 66 from Jackson. Elevation, 40.6709.

P. B. M. 28.—At Tchula, Holmes County, Miss. Is cross cut in southeast bolt holding roller to southeast pier of drawbridge over Tchula Lake. Elevation, 42.1994.

P. B. M. 27.—Pipestone bench at Tchula, Holmes County, Miss., in east corner of yard to Tchula section house belonging to the Illinois Central Railroad. Elevation, 41.0373.

T. B. M. 171.—Nail in root of a 0.3-meter elm, 35 meters west of track, opposite siding leading to sawmill, and about 150 meters north of milepost 82 from Jackson. Elevation, 42.9797.

P. B. M. 26.—Pipestone bench at Sidon, Leflore County, Miss., in the northwest corner of yard to the Illinois Central Railroad section house, and about 35 meters south of depot. Elevation, 43.4783.

T. B. M. 164.—Nail in root of a 0.2-meter bois d'arc 6 meters northwest of depot at Sidon. Elevation, 44.3973.

P. B. M. 25.—Pipestone bench at Greenwood, Leflore County, Miss., in north corner of yard to Greenwood section house belonging to the Illinois Central Railroad. It is about 70 meters east of the depot. Elevation, 44.3518.

T. B. M. 156.—Spike in root of a 0.4-meter water oak 45 meters north of the

Southern Railway track and 35 meters west of store of Portwood & Williams, 75 meters west of Illinois Central Railroad depot. Elevation, 45.0799.

P. B. M. 24.—Pipestone bench at Greenwood, Leflore County, Miss., in west corner of yard to Leflore County court-house, at corner of Front and Cotton streets. Elevation, 45.5482.

T. B. M. 155a.—Nail in root of a 1.2-meter cottonwood 8 meters east of A. M. Craig's store at corner of Cotton and Front streets. Elevation, 46.6808.

T. B. M. 155.—Nail in root of a 0.7-meter gum 20 meters north of track at 40 meters northwest of sign reading, "R. R. crossing, one-half mile," and on east side of a ditch. Elevation, 45.3260.

P. B. M. 23.—At Fort Loring, Leflore County, Miss. Is cross cut in stone coping on the north end of the east pier supporting the Southern Railway drawbridge over Yazoo River. It is at the southeast corner of the iron rest plate and is marked:
U S
x Elevation, 47.1619.
P B M

P. B. M. 22.—Pipestone bench, at Fort Loring, Leflore County, Miss. Is in fence corner of fences dividing railway right of way, public road, and small garden, on McLemore and Baird's place. It is 12 meters south of the Southern Railway track and 6 meters west of right bank of Yazoo River. Elevation, 45.3038.

P. B. M. 21.—Pipestone bench at Ittabena, Leflore County, Miss., in southeast corner of yard around Letulah school, and about 2.5 meters from east fence and 1.5 meters from south fence. Elevation, 44.2927.

T. B. M. 135.—Nail in root of a 0.3-meter red oak, 15 meters south of track and 40 meters east of milepost 424. Elevation, 41.7490.

T. B. M. 131.—Nail in root of a 0.2-meter cottonwood, 8 meters south of track and 80 meters east of milepost 428. Elevation, 42.5088.

P. B. M. 20.—Pipestone bench about 750 meters northwest of Baird, Sunflower County, Miss., about 18 meters east of the south end of the Southern Railway approach to bridge over Sunflower River. It is in the northwest corner of yard belonging to house occupied by E. B. and G. B. Wade, and owned by J. J. Oliver. Elevation, 41.9126.

P. B. M. 19.—Pipestone bench on right bank of Sunflower River, Sunflower County, Miss., about 14 meters west of north end of Southern Railway trestle approach to drawbridge over Sunflower River, and in southeast corner of yard to cabin occupied by Buck Willis on W. A. Pollock's place. Elevation, 41.1851.

P. B. M. 18.—About 1 kilometer northwest of Baird, Sunflower County, Miss. The point is marked by a cross cut on top of and on west end of south pier of the Southern Railway bridge over Sunflower River. It is 0.8 meter from south edge of pier, 0.23 meter south of track on pier, 0.78 meter from west edge of pier, and 0.4
U S
meter west of joint in stone. It is marked x Elevation, 44.7300.
B M

T. B. M. 129.—Nail in root of an 0.8-meter gum, 30 meters south of track and cattle gap, and 200 meters west of milepost 430. Elevation, 41.9771.

P. B. M. 17.—Pipestone bench at Indianola, Sunflower County, Miss. Is in the southwest corner of grounds around the county court-house. Elevation, 41.9981.

P. B. M. 16.—Pipestone bench at Heathman, Sunflower County, Miss. It is at west end of young bois d'arc hedge between board and wire fences in front of yard belonging to residence of J. A. Crawford. It is 2 meters northeast of northeast corner of his store and 5 meters south of Southern Railway track (main line). Elevation, 43.2072.

T. B. M. 121.—Nail in root of a 0.5-meter oak, 35 meters south of track and 200 meters west of milepost 438. Elevation, 42.9315.

P. B. M. 15.—Pipestone bench at "The Bogue," Washington County, Miss. It is in the south corner of yard to cabin occupied by John Bailey (colored), on Bob Ingram's place. It is 1 meter from left bank of Bogue Phalia and about 40 meters northwest of Southern Railway trestle across the Bogue. It is directly opposite the ginhouse on the right bank, and about 75 meters southeast of highway bridge. Elevation, 41.2011.

P. B. M. 14.—Pipestone bench at Stoneville, Washington County, Miss. It is in the east corner of orchard belonging to house occupied by A. Jones and belonging to J. C. Greenley. Orchard is between house and grocery store belonging to Yuen Sing & Co. It is 0.7 meter from front fence and 0.4 meter from porch of store. Elevation, 43.4906.

T. B. M. 108.—Nail in root of a 0.5-meter elm 15 meters south of track and 150 meters west of milepost 450. Elevation, 42.7026.

T. B. M. 107.—Nail in root of a 0.6-meter elm 25 meters north of track and 325 meters west of milepost 451. Elevation, 42.4904.

T. B. M. 105.—Nail in root of a 0.3-meter hackberry 20 meters south of track and 75 meters east of milepost 453. Elevation, 42.5698.

T. B. M. 104.—Nail in root of a 0.2-meter willow 25 meters south of track 10 meters east of road crossing, and 75 meters east of milepost 454. Elevation, 43.3523.

T. B. M. 103.—Nail in root of a 1.2-meter pecan 15 meters south of track and 300 meters east of milepost 455 and 100 meters west of cattle guard. Elevation, 43.8012.

T. B. M. 101.—Nail in root of a 0.4-meter sycamore 125 meters west of Southern Railway track, in vacant lot just in front of new court-house. Elevation, 44.8542.

C. and G. S. P. B. M. Greenville, No. 1.—(See descriptions, Parkeville, La., to Greenville, Miss., via Arkansas City, Ark., p. 1489.)

DELHI TO TENSAS RIVER, VIA WARSAW LANDING, BAYOU MAÇON, LA.

P. B. M. 13.—See descriptions, Delta to Coushatta, La. (p. 1491).

B. M. Delhi.—See descriptions, Delta to Coushatta, La. (p. 1491).

T. B. M. 1.—On northeast corner of brick pier of northeast corner of S. Blum's store at Delhi, La. Pier supports iron column at northeast corner of porch in front of store. Elevation, 35.5614.

T. B. M. 2.—Boat spike in root of a 1-meter white oak, east side of Delhi-Warsaw road, 1 kilometer from Delhi, 150 meters south of chimneys marking residence site of Capt. H. P. Wells, and on west side of tree. Elevation, 35.3879.

T. B. M. 3.—Boat spike in root of a 1-meter white oak, on west side of Delhi-Warsaw road, at northeast corner of James place field and 75 meters south of cabin on Scott place. Elevation, 34.6192.

T. B. M. 4.—Spike in root of a 0.4-meter sweet gum, east side of road and 14 meters south of southwest corner of S. Phillips's place. Elevation, 33.9141.

T. B. M. 5.—Spike in root of a 1-meter black oak, west side of road at edge of small deadening, and 109 meters southeast of small house on Crouch place. Elevation, 33.1614.

T. B. M. 6.—Spike in root of a 1-meter white oak on east side of road, 200 meters south of southwest corner of Insley's place and 220 meters north of culvert over Pussy Bayou. Elevation, 32.9640.

T. B. M. 7.—Spike in root of a 1.5-meter cow oak, on east side of road and on right bank of bayou, 300 meters south of Mr. Armstrong's house. Elevation, 31.1030.

T. B. M. 8.—Spike in root of a black hickory on west side of road, 30 meters south of southeast corner of Porter place and 40 meters south of where road crosses swale. Elevation, 31.8038.

T. B. M. 9.—Spike in root of scaley bark hickory, 15 meters west of road, 282 meters south of house on Griffin place, and 166 meters south of branch. Elevation, 31.8423.

T. B. M. 10.—Spike in root of a 0.4-meter red elm, on west side of road and 90 meters south of Griffin's front gate. Elevation, 32.4925.

P. B. M Griffin.—Pipe-flange bench on Jackson place, Franklin Parish, La., in west corner of barn lot adjoining yard to plantation house owned by Tom Griffin. Is about 830 meters from mouth of Pullaway Bayou and near Jackson or Pullaway Landing. Elevation, 32.7123.

B. M. 26 (Maçon survey, 1898).—Nail in root of a 0.8-meter water oak on edge of right bank of Pullaway Bayou and about 20 meters back from right bank of Bayou Maçon at Jackson Landing. Elevation, 28.6325.

T. B. M. 11.—Spike in root of a 0.6-meter sweet gum on east side of road, 175 meters south of house on property of Mrs. Sallie Anderson, of Delhi, and about midway of short lane, south end of which is nearly opposite the old graveyard on east side of road and 600 meters north of Dover post-office. Elevation, 33.1996.

T. B. M. 12.—Spike in root of a 0.4-meter red elm on west side of road about 108 meters south of Dover post-office. Elevation, 32.7464.

T. B. M. 13.—Spike in root of a 0.2-meter sweet gum, 5 meters east of road and 24 meters east of Bellevue church (colored). Elevation, 33.8309.

T. B. M. 15.—Spike on root of a 1-meter white oak, west side of road at northeast corner of inclosure, 225 meters south of Lamar post-office. Elevation, 33.1547.

T. B. M. 16.—Spike in root of a 1-meter black oak where road turns to Andrews Ferry, and 200 meters east of gin at Lamar. Elevation, 34.7291.

T. B. M. 17.—Spike in root of a 1-meter sweet gum, west side of road where side road turns off for Andrews Ferry. Elevation, 34.4594.

B. M. 30 (Maçon survey, 1898).—Nail in root of a 1.2-meter red oak, 8 meters in front of right top bank (hills) of Bayou Maçon, about 50 meters below large warehouse at Warsaw Landing, and about 25 meters below residence of Mr. McPherson (owned by Mrs. Pennybaker). Elevation, 31.9693.

P. B. P. Newcomer.—Pipe-flange bench at Sunrise Landing, Franklin Parish, La.

Is in northwest corner of lot adjoining front yard of J. L. Newcomer's residence, about 1.6 kilometers below Warsaw Landing, on Bayou Maçon. Elevation, 34.1862.

T. B. M. 19.—Nail in root of a 0.6-meter honey locust on left bank of Bayou Maçon, 80 meters above cabin and 700 meters above Warsaw Landing. Elevation, 28.8400.

T. B. M. 20.—Spike in root of a 0.5-meter pin oak on left bank of Bayou Maçon, 1 kilometer below Andrews Ferry and 88 meters below negro shanty on Montgomery's place. Elevation, 28.7046.

T. B. M. 21.—Spike in root of a 1.2-meter pin oak in Mr. Andrews's field, on north side of lane and 200 meters south of Bayou Maçon. Elevation, 29.4568.

B. M. 29. (*Maçon survey, 1898*).—Spike in root of a 1.2-meter pin oak on second bank of Bayou Maçon and 70 meters above front-yard gate of Mr. Andrews's residence. Elevation, 29.3137.

T. B. M. 26.—Spike in root of a 0.5-meter red elm on south side of road to McPherson's, 92 meters east of where road crosses small deadening in small lake and 160 meters west of large bayou. Elevation, 25.8379.

T. B. M. 28.—Spike in root of a 0.6-meter pecan 15 meters south of road at edge of old field and 100 meters back from right bank of Tensas River at a point 600 meters below McPherson's house. Elevation, 27.8491.

B. M. 25 (*Tensas survey, 1898*).—Nail in root of a 0.3-meter pecan on east side of road in front of house occupied by James McPherson and on the Gray place. House stands about 40 meters back from the right bank of Tensas River in a small clearing. Elevation, 28.7817.

B. M. 24 (*Tensas survey, 1898*).—Nail in cottonwood, right bank of Tensas River, in front of house of C. B. Clark. Elevation, 29.1575.

P. B. M. Gray.—Pipe-flange bench on Gray place, Madison Parish, La., in southwest corner of yard to house occupied by James McPherson. Bench is 44 meters back from right bank of Tensas River. Elevation, 29.1221.

RAYVILLE TO CONCORDIA, LA.

P. B. M. 16.—See descriptions, Delta to Coushatta, La. (p. 1491).

P. B. M. 17.—See descriptions, Delta to Coushatta, La. (p. 1492).

T. B. M. 1.—Wire nail in root of a 0.4-meter mulberry on north side of court-house at Rayville, La. Elevation, 31.8059.

T. B. M. 2.—Boat spike in root of an 0.8-meter white oak, 60 meters west of track and 20 meters northwest of cabin which is near first cattle gap south of Rayville, La. Elevation, 30.5939.

T. B. M. 5.—Boat spike in root of a 1-meter sycamore, 15 meters east of track and 50 meters west of P. B. M. Burke. Elevation, 28.9284.

P. B. M. Burke.—Pipe-flange bench at Burke Station, 8 kilometers below Rayville, and in Richland Parish, La. Is about 50 meters east of track and 10 meters north of an indistinct road leading back to farmhouse. Elevation, 29.2365.

T. B. M. 6.—Boat spike in root of a 0.4-meter oak, 15 meters east of track and 300 meters above first field above Burke. The letters U S are cut on tree above bench. Elevation, 28.6314.

T. B. M. 8.—Boat spike in root of a 0.6-meter sweet gum, 15 meters east of track, 5 meters south of fence corner, and 500 meters south of schoolhouse above Archibald. The letters U S are cut on tree above bench. Elevation, 28.7416.

P. B. M. Archibald.—Pipe-flange bench at Archibald, Richland Parish, La. Is in northwest corner of yard of J. J. Archibald, about 8 meters east of center of track, and 30 meters south of depot. Elevation, 29.6116.

T. B. M. 9.—Boat spike in root of a 0.3-meter hickory, 15 meters east of track, 150 meters southeast of cabin, and 1.6 kilometers south of Archibald. Elevation, 29.8346.

P. B. M. Mangham.—Pipe-flange bench at Mangham, Richland Parish, La. Is in southeast corner of yard of H. H. Nash and 40 meters west from track at point 10 meters south of south end of side track. Elevation, 28.9287.

T. B. M. 11.—Boat spike in root of a 0.2-meter sweet gum, 15 meters west of track and 45 meters north of end of long trestle over Big Creek swamp. Elevation, 28.1947.

P. B. M. Big Creek.—Pipe-flange bench at Big Creek, Franklin Parish, La. Is on property of John Guinn, about 70 meters east of the left bank of Big Creek where the New Orleans and Northwestern Railway crosses it, and 25 meters south of track. Elevation, 28.8562.

T. B. M. 12.—Boat spike in root of a 0.5-meter post oak, 15 meters east of track, 25 meters south of corner of field, and 4½ telegraph poles south of milepost 60. Elevation, 28.8220.

P. B. M. Baskin.—Pipe-flange bench at Baskin Station, Franklin Parish, La., about 25 meters west of track, directly opposite the north end of platform, and 5 meters north of road. Elevation, 28.6613.

P. B. M. Steele.—Pipe-flange bench at road crossing of the New Orleans and Northwestern Railway at what was formerly known as Steele Switch, Franklin Parish, La., about 15 meters east of track and 40 meters south of trestle and at edge of dirt road. Elevation, 28.1997.

T. B. M. 17.—Boat spike in root of a 0.4-meter white oak, 15 meters east of track, 150 meters north of cattle gap, and 1½ telegraph poles south of milepost 53. Elevation, 27.7653.

P. B. M. Winnsboro.—Pipe-flange bench at Winnsboro, Franklin Parish, La., in southwest corner of lot owned by Mrs. Adams, directly opposite the depot and about 40 meters west of track. Elevation, 28.1707.

T. B. M. 19.—Boat spike in root of a 0.3-meter pine, 15 meters east of track, at first cattle gap below first curve south of Turkey Creek. Elevation, 28.8093.

T. B. M. 20.—Spike in root of a 0.2-meter elm, 15 meters west of track, 10 meters east of wagon road, on left bank of Turkey Creek and 100 meters south of Cattle Gap. Elevation, 26.8002.

P. B. M. Eden.—Pipe-flange bench at Eden station, Franklin Parish, La. Is on property of A. W. McDuff, 10 meters east of track in corner of fence, about 80 meters north of platform, and about 100 meters east of McDuff's residence. Elevation, 28.0257.

P. B. M. Gilbert.—Pipe-flange bench at Gilbert, Franklin Parish, La., about 40 meters west of track, in the southwest corner of a garden owned by Ephraim Williams, and about 150 meters south of depot. Elevation, 29.8791.

T. B. M. 27.—Boat spike in root of a 0.5-meter elm, 20 meters west of track, just at edge of woods of only field between Gilbert and Wisner. Elevation, 29.5758.

P. B. M. Wisner.—Pipe-flange bench at Wisner, Franklin Parish, La., about 20 meters east of track at south end of side track, and 200 meters south of depot. Elevation, 28.9640.

T. B. M. 29.—Boat spike in root of a 0.4-meter hickory, 15 meters east of track, 15 meters south of road crossing track, 9 telegraph poles south of milepost 37. Elevation, 28.4529.

P. B. M. Elam.—Pipe-flange bench at Elam, Franklin Parish, La., at north edge of Mrs. L. Allen's store, 30 meters west from track and 2 meters west from pump at northeast corner of store. Elevation, 28.1914.

T. B. M. 30.—Boat spike in root of a 0.2-meter thorn, 15 meters west of track and two telegraph poles north of milepost 35. Elevation, 23.9830.

P. B. M. Peck.—Pipe-flange bench at Peck station, Catahoula Parish, La., in the northeast corner of cotton field belonging to H. and C. Newman, of New Orleans, and about 25 meters west of seed house at station platform. Elevation, 28.9787.

T. B. M. 31.—Boat spike in root of a 1-meter pin oak, 10 meters east of track and 250 meters south of milepost 33. Elevation, 28.4971.

P. B. M. Newman.—Pipe-flange bench on property of H. and C. Newman, 4 kilometers south of Peck, Catahoula Parish, La., on north bank of bayou, and 10 meters east of north end of trestle over bayou. Elevation, 27.9453.

P. B. M. Chisum.—Pipe-flange bench at Chisum, Catahoula Parish, La. It is 2.3 kilometers north of Florence, and 30 meters west of track, and on south edge of plantation road on H. and C. Newman's place. Elevation, 28.0477.

P. B. M. Florence.—Pipe-flange bench at Florence, Sicily Island post-office, Catahoula Parish, La., is about 15 meters west of track, on railroad property, and about 125 meters north of depot. Elevation, 28.2410.

T. B. M. 35.—Boat spike in root of a 0.3-meter elm, 10 meters east of track, about 250 meters south of small store, 300 meters north of railroad crossing and 5 telegraph poles north of milepost 26. Elevation, 22.5384.

P. B. M. Copeland.—Pipe-flange bench at Copeland, Catahoula Parish, La., about 35 meters east of track and 35 meters southeast from station platform. Elevation, 25.7065.

T. B. M. B.—Boat spike in root of sweet gum, 100 meters north of Copeland Place residence. Elevation, 26.0621.

T. B. M. C.—Boat spike in root of a 0.2-meter oak on east side of road, on right bank of Tensas River at Anchor Place. Elevation, 24.7521.

P. B. M. Kirk.—Pipe-flange bench at Kirks Ferry, Catahoula Parish, La., in southeast corner of yard of S. F. Kiper on Tensas River and above mouth of Choctaw Bayou, about 10 meters west of main top bank of river and 20 meters southeast of residence. Elevation, 25.9805.

P. R. P. Tensas.—Pipe-flange bench at Greenville, Catahoula Parish, La., in southwest corner of lot, 80 meters east of track, and about 40 meters west of main right bank of river. Elevation, 25.8363.

P. B. M. Lee Bayou.—Pipe-flange bench at Lee Bayou, Catahoula Parish, La., on bank of Lee Bayou, about 50 meters west of track of New Orleans and Northwestern Railway. Elevation, 25.5035.

P. R. P. Clayton.—Pipe-flange bench at Clayton, Concordia Parish, La., at corner of fence, about 25 meters northeast of track, 10 meters southeast of bank of Tensas River, and 25 meters north of depot. Elevation, 24.8773.

P. B. M. Cypress.—Pipe-flange bench at Cypress City, Concordia Parish, La., in yard of Henry Elerbee (colored), and 85 meters west of track of New Orleans and Northwestern Railway. Elevation, 23.9342.

P. B. M. Helena.—Pipe-flange bench at Helena, Concordia Parish, La., on north side of lane, and about 20 meters north of track, and on property of Graves Veaton Company. Elevation, 24.5905.

P. B. M. Concordia.—Pipe-flange bench at Concordia station, Concordia Parish, La., 5 meters south of Natchez, Red River and Texas Railroad, 2 meters west from line of east side of depot, and 5 meters west from road crossing track at east end of depot. Elevation, 24.5699.

T. B. M. A.—Railroad spike in root of a 1-meter pine, 10 meters south of levee. Elevation, 25.5588.

B. M. 384.—Copper tag above zinc spike, reads: U.S.B.M. 384 Elev. 88.84. Bench is 1.5 meters above ground on same tree as T. B. M. A. Elevation taken on square part of spike. Elevation, 26.9578.

T. B. M. 9.—See descriptions, Jonesville to Vidalia, La., and Natchez, Miss. (p. 1513).

ARCHIBALD TO BELLEVUE AND THREE RIVERS, LA.

P. B. M. Archibald.—See descriptions, Rayville to Concordia, La. (1506).

T. B. M. 53.—Spike in root of a black gum on south side of Archibald-Alto road, 175 meters east of northeast corner of field, 1 kilometer from depot at Archibald. Elevation, 27.7752.

T. B. M. 54.—On root of a 0.5-meter pin oak on south side of Archibald-Alto road and also Winnsboro-Rayville road, 20 meters west of small bridge and 240 meters east of where road to Alto leaves the Winnsboro-Rayville road. Elevation, 27.8295.

T. B. M. 55.—On root of a 1-meter sycamore, 15 meters south of Shady Grove church. Elevation, 28.4544.

T. B. M. 56.—On root of an 0.8-meter post oak on south side of Archibald-Alto road, 50 meters north of Little Creek Methodist church. Elevation, 28.6927.

T. B. M. 57.—On a 1-meter black oak on south side of Archibald-Alto road, 10 meters west of intersection of road from north and opposite southeast corner of William Hemley place. Elevation, 28.4902.

T. B. M. 58.—Boat spike in root of a 0.9-meter white oak on north side of Archibald-Alto road, 220 meters from intersection of road from southwest, 400 meters west of residence of William Hemley. Elevation, 27.2208.

T. B. M. 59.—Boat spike in root of a 1-meter pin oak on south side of Archibald-Alto road, and in front of residence of Mr. Thomason, 1 kilometer east of Alto. Elevation, 28.2324.

T. B. M. Alto.—Spike in root of a 1-meter overcup oak at front, upstream corner outside of yard to residence of J. G. McCormick, Alto, La., and about 20 meters from bank of Boeuf River. Elevation, 28.9095.

P. R. P. Alto.—Pipe-flange bench at Alto, Richland Parish, La., in southwest corner of yard of E. H. Cook, on north side of Archibald road and 20 meters east of left bank of Boeuf River. Elevation, 28.7317.

T. B. M. 60.—Boat spike in root of a 1.5-meter sweet gum, 15 meters west of river road, 200 meters north of cabin on William Hemley's place, and 500 meters below point where road turns across neck. Elevation, 27.9777.

T. B. M. 61.—Boat spike in root of a 0.7-meter sassafras, 100 meters north of house on Mulhern place, 400 meters south of Mulhern's residence, on west side of lane on Alto-Charlieville road. Elevation, 29.1549.

T. B. M. 62.—Boat spike in root of a 0.6-meter cow oak on west side of lane on Alto-Charlieville road, 150 meters south of Mount Zion Church and 5 meters east of edge of cypress swamp. Elevation, 28.4775.

P. B. M. Harland.—Pipe-flange bench at northwest corner of store at Harland Field, Richland Parish, La., 20 meters from bank of Bœuf River and 75 meters above point where second bank joins main bank. Elevation, 28.6996.

T. B. M. 63.—Boat spike in root of an 0.8-meter sweet gum, 50 meters below Harland Field warehouse and 15 meters from left bank of Bœuf River. Elevation, 27.9894.

T. B. M. 64.—Boat spike in root of a 1-meter black oak, on south side of road, 75 meters east of east end of lane, 300 meters west of small house on Bacle place, and 400 meters east of house on old Dyson place. Elevation, 28.2314.

T. B. M. 65.—Boat spike in root of a 1.3-meter sweet gum, on north side of road, 40 meters west of Adile church (colored), 100 meters west of house on Dyson place, and 100 meters east of point where road strikes river. Elevation, 28.4862.

T. B. M. Charlieville.—Nail in root of a 0.4-meter walnut in front of warehouse at Charlieville, and 20 meters from left bank of Bœuf River. Elevation, 27.4866.

P. A. P. Stokes.—Pipe-flange bench on Stokes place, opposite Charlieville, Richland Parish, La., 40 meters from right bank of Bœuf River, 25 meters from cabin, and 150 meters below Stokes's residence. Elevation, 28.2132.

P. R. P. Stokes.—Pipe-flange bench on Stokes place, Richland Parish, La., on right bank of Bœuf River, 18 meters from main top bank and 20 meters upstream from cabin occupied by Henry Hunter. Elevation, 28.2622.

B. M. 62 (Boeuf Survey, 1898).—Nail in root of a 0.5-meter sweet gum, on edge of left bank of Boeuf River, 5 meters south of point where road crossing neck of bend below Charlieville reaches river on lower side of bend, and 100 meters west of cabin on Tanglewood place. Elevation, 27.2410.

T. B. M. Holly Grove.—On root of a 1-meter catalpa on left bank of Boeuf River, at outer upstream corner of Frank Hatch's warehouse. Elevation, 27.6055.

P. R. P. Hatch.—Pipe-flange bench at Holly Grove Landing, Richland Parish, La., in northwest corner of yard in front of Frank Hatch's residence, 60 meters northwest from residence, 100 meters east from landing, and 20 meters from left bank of Boeuf River. Elevation, 27.5624.

T. B. M. 66.—Boat spike in root of a 1.3-meter sweet gun, on edge of left bank of Boeuf River, 200 meters below residence of R. McIntosh, and 50 meters above shanty on the McIntosh place. Elevation, 26.5056.

B. M. 64 (Boeuf Survey, 1898).—Nail in root of a 1.2-meter red oak, on edge of left bank of Boeuf River, 100 meters below point where road turns across neck of bend and at northwest corner of McIntosh place. Elevation, 26.5334.

P. R. P. Noble 2.—Pipe-flange bench on property of C. M. Noble, Richland Parish, La. It is 40 meters from left bank of Boeuf River, in corner of pasture where road from Holly Grove Landing turns down left bank of river after crossing neck of first bend below Holly Grove. Elevation, 26.7854.

B. M. 70 (Boeuf Survey, 1898).—Nail in root of a 0.9-meter post oak 10 meters from left bank of Boeuf River, 200 meters below where road turns across neck of bend and 70 meters below a cabin. Elevation, 26.3341.

B. M. 71 (Boeuf Survey, 1898).—Nail in root of a 0.6-meter cow oak on edge of left bank of Boeuf River and in bight of bend on the Thomason heirs' place, 500 meters above where road crosses neck to Landerneau post-office. Elevation, 26.3320.

P. R. P. Elmore.—Pipe-flange bench on property of Elmore and King, 400 meters below cabin on Thomason place, Richland Parish, La., 5 meters west of road cutting across neck from Thomason place to Landerneau and 90 meters from left bank of Boeuf River. Elevation, 26.4262.

P. R. P. Doucier.—Pipe-flange bench on property of the "Green Grove" church, opposite Landerneau and in Richland Parish, La. It is on the east side of road crossing neck, 40 meters east of east wall of church, extended, and 15 meters south of south wall, extended. Elevation, 27.0337.

T. B. M. 67.—Boat spike in root of a 1.5-meter water oak, on right bank of Boeuf River, in front of gin at Landerneau. Elevation, 25.5608.

T. B. M. 68.—Boat spike in root of a 0.6-meter persimmon, in old field, 5 meters west of road, 200 meters south of edge of woods below Landerneau, 200 meters from bank of Boeuf River, and 500 meters above Girod's residence. Elevation, 25.7207.

T. B. M. 69.—Boat spike in root of a 1.9-meter red oak, in old field, 600 meters below Girod's residence, 50 meters above edge of woods, 15 meters east of road, and 150 meters from right bank of river. Elevation, 25.9690.

T. B. M. 70.—Boat spike in root of a 1-meter white oak, 10 meters west of road, 200 meters north of Harris's residence, 50 meters north of south edge of wooded strip between Girod's and Harris's places. Elevation, 26.6935.

P. R. P. Harris.—Pipe-flange bench on Harris place, 300 meters above Bird Lake Landing, Caldwell Parish, La. It is 3 meters west of road, on field side of fence, 10 meters below angle, 100 meters above southwest corner of field, and 40 meters from bank of Boeuf River. Elevation, 25.9996.

T. B. M. 71.—Boat spike in root of a 1.2-meter black gum, on south side of road, 800 meters below Bird Lake Landing, 100 meters below where road begins to follow bank of cypress brake, and 15 meters back of brake. Elevation, 26.0184.

T. B. M. 72.—Boat spike in root of a 0.9-meter pin oak, at lower edge of wooded strip between Bird Lake Landing and Duchesne place, on east side of road, 15 meters west of bank of cypress brake, 75 meters northwest of northwest corner of field, 400 meters back from river, and 800 meters above Boeuf River post-office. Elevation, 25.4149.

T. B. M. 73.—Spike in root of a post oak, 10 meters west of road, 300 meters east of main wood line, in old field below Boeuf River post-office, 75 meters back from main bank of Boeuf River where road cuts across from post-office to Brandin's place. Elevation, 25.1390.

B. M. 81 (*Boeuf Survey, 1898*).—Nail in root of a 1.2-meter pin oak, 5 meters from bank of Boeuf River, 150 meters northwest of residence of Leopold Brandin. Elevation, 25.7345.

P. R. P. Wheeler.—Pipe-flange bench at old Doucier Landing, on Paul Brandin's place, Caldwell Parish, La., 12 meters from right bank of Boeuf River, 300 meters below where road crossing neck from the old Doucier place reaches river. Elevation, 26.0282.

T. B. M. 74.—Boat spike in root of a 1-meter black gum, on west side of road at lower edge of narrow wooded strip between two old fields immediately below old Doucier Landing and 10 meters from right bank of Boeuf River. Elevation, 25.3220.

T. B. M. 75.—Boat spike in root of an 0.8-meter pin oak at upper end of old field on Recoulet place. Field is grown up in bushes. Bench is at fork of road, one fork leading down the river, the other leading back to an old field. Bench is 200 meters from right bank of Boeuf River and 75 meters north of small bayou. Elevation, 24.8596.

T. B. M. 76.—Boat spike in root of a 1-meter white oak in woods where road runs back of old Recoulet place toward Hebert's on east side of road and 600 meters south of back line of old field. Elevation, 24.0054.

T. B. M. 77.—Boat spike in root of a 0.5-meter pecan, on west side of road crossing from old Recoulet field to Hebert's place at a point 300 meters north of an old hurricane track 500 meters north of uppermost field at Hebert's and in thick woods. Elevation, 23.7490.

P. R. P. Hebert.—Pipe flange bench 250 meters above Heberts Landing, Caldwell Parish, La., in northwest corner of garden back of house of widow Johnson, 16 meters from right bank of Boeuf River and 60 meters below a deep gully entering river. Elevation, 25.2321.

B. M. 91 (*Boeuf Survey, 1898*).—Nail in root of a 1.2-meter post oak, 10 meters from right bank of Boeuf River, 50 meters above Hebert's house at Heberts Landing and in front of a large mound. Elevation, 25.8343.

P. R. P. La Fourche.—Pipe flange bench, 400 meters southwest of Heberts Landing, Caldwell Parish, La., in southeast corner of field on Hebert's place and on west side of road to Columbia, which crosses neck from Boeuf River to Bayou La Fourche. Bench is on top bank of Bayou La Fourche. Elevation, 25.0622.

T. B. M. 78.—Boat spike in root of a 0.7-meter bitter pecan, on north side of Hebert-Columbia road, 150 meters northwest of field on Davis Hew's place, and 200 meters east of beginning of La Fourche swamp proper. Elevation, 23.3481.

T. B. M. 79.—Boat spike in root of a 0.7-meter overcup oak in La Fourche swamp, midway between two shallow swales crossing road from Heberts to Columbia, and on north side of road. Elevation, 21.7330.

T. B. M. 80.—Boat spike in root of a 0.5-meter bitter pecan in La Fourche swamp, 55 meters north of Bayou La Fourche, at first point west of Heberts, where road runs close to bayou, and on north side of road; 10 meters east of shallow swale. Elevation, 21.4855.

T. B. M. 81.—Boat spike in root of a 1.2-meter pin oak near north end of Perrins Island, 200 meters below junction of road from Heberts (north fork) with road from Boeuf River post-office, and 100 meters southwest from northwest corner of field on Perrins Island. Bench is on west edge of road. Elevation, 25.1615.

T. B. M. 82.—Boat spike in root of a 0.2-meter Spanish oak on south side of Perrines Island, 20 meters northwest of cabin, 200 meters northeast of bridge over Bayou La Fourche, and on the east side of the Boeuf River-Columbia road. Elevation, 26.3116.

T. B. M. 83.—Boat spike in root of a 1.2-meter pin oak on west side of Boeuf River-Columbia road at a point 75 meters south of where road turns off to the southwest, and 150 meters north of where road passes point of old field 250 meters north, along road, to small bayou. Elevation, 24.2125.

T. B. M. 84.—Boat spike in root of a 1-meter pin oak 5 meters west of Boeuf River-Columbia road, 200 meters southwest from northwest corner of field on Bellevue place. Elevation, 25.0782.

T. B. M. 85.—Boat spike in root of a 1.1-meter pin oak 10 meters west of Boeuf River-Columbia road, 75 meters south of small cleared space, unfenced, and west of road, and 100 meters north of where road makes obtuse bend turning to a northeast and southwest course. Elevation, 25.1674.

T. B. M. 86.—Boat spike in root of a 1.3 meter pin oak, 10 meters west of Boeuf River-Columbia road, 50 meters northwest of end of long lane running to Ouachita River front at Bellevue Landing. Elevation, 25.5105.

T. B. M. 87.—Boat spike in root of a 4-pronged sweet gum, in field 2 meters west of fence, and at west end of a short east and west stretch in long lane coming to Ouachita River front at Bellevue Landing. Elevation, 25.7622.

T. B. M. 135.—See descriptions, Monroe to mouth of Black River, La. (p. 1476).

T. B. M. 134.—Probably disturbed.

P. R. P. Columbia.—Pipe flange bench about 2.4 kilometers below and opposite Columbia, and in Caldwell Parish, La., 7 meters north of fence forming south boundary, and 210 meters west of fence forming east boundary of I. Davis's place. Elevation, 27.0072.

T. B. M. 137.—See descriptions, Monroe to mouth of Black River, La. (p. 1476).

T. B. M. 138.—See descriptions, Monroe to mouth of Black River, La. (p. 1476).

T. B. M. 88.—Boat spike in root of a 0.4 meter thorn, on north side of Columbia-Harrisonburg road, where it crosses through back swamp in crossing from Bellevue to Wade place, and 300 meters west by north from northeast corner of field around which road makes an obtuse bend, and runs southeast to river at upper end of Wade place. Elevation, 24.7653.

P. R. P. Wade.—Pipe flange bench on Wade place, Caldwell Parish, La., 5 meters below cabin occupied by Henry Neil (1896) and on line with posts of front gallery, 15 meters east from road, 58 meters from left bank of river, 50 meters south of lane, and 150 meters below steam gin. Elevation, 27.3203.

T. B. M. 89.—Boat spike in root of a 0.6-meter sweet gum on north side of Three Rivers road at a point 500 meters toward Boeuf River from north end of lane coming to Ouachita River, just below gin on Wade place. Bench is 150 meters east of where road makes obtuse bend, turning from a northeast to a southwest course, 150 meters west of where road crosses a buckshot flat. Elevation, 24.7761.

T. B. M. 90.—Boat spike in root of a 0.4-meter pecan on south side of Three Rivers road, 60 meters west of where a dim road comes in from north, 800 meters west of house owned by Mr. Null, and 300 meters east of where road leaves a cypress brake on the north. Elevation, 23.5617.

T. B. M. 91.—Boat spike in root of a 0.4-meter pin oak, 125 meters east of a buckshot flat, 250 meters west of house on Humble place on south side of Three Rivers road, and 300 meters east of house owned by Mr. Null. Elevation, 24.9302.

T. B. M. 92.—Boat spike in root of a 1.3-meter pin oak on north side of Three Rivers road, 300 meters east of southeast corner of field on Humble place and 150 meters west of bridge over Bayou Crew. Elevation, 24.2005.

T. B. M. 93.—Boat spike in root of an 0.8-meter pin oak, 60 meters south of Bayou Crew, on east side of road turning off to the south at the south end of bridge over Bayou Crew. Bench is not on Three Rivers road. Elevation, 24.3635.

T. B. M. 94.—Boat spike in root of an 0.8-meter thorn, 125 meters east of northeast corner of field on Big Ridge place, on south side of Three Rivers road, and in front of shanty in woods 10 meters north of road. Elevation, 24.0279.

T. B. M. 95.—Boat spike in root of a 1-meter maple (leaning to south) on south side of Three Rivers road and 30 meters east of northeast corner of field on Big Ridge place. Elevation, 23.1397.

T. B. M. 96.—Boat spike in root of a 1-meter overcup oak on north side of Three Rivers road, 1 kilometer southeast of southeast corner of last field between Ouachita and Boeuf rivers and 400 meters northwest, along road to a pin-oak ridge and in a buckshot flat. Elevation, 22.2277.

P. R. P. Three Rivers.—Pipe-flange bench at the Boeuf River crossing of road to Columbia from Winnsboro, and in Caldwell Parish, La. Bench is in grove of small pecans, 30 meters west of right bank of Boeuf River, 25 meters west of stretch of road paralleling river, 25 meters north of an east and west stretch in road, and 75 meters below lower end of small island in river. Elevation, 22.7672.

GILBERT TO NEW LIGHT, LA.

P. B. M. Gilbert.—See descriptions, Rayville to Concordia, La. (p. 1507).

T. B. M. 29.—Boat spike in root of a 1.5-meter black oak, 18 meters east of the New Orleans and Northwestern Railway, immediately above edge of clearing running to Gilbert, and at crossing of east and west road. Bench is 1.2 kilometers above Gilbert and 350 meters north of point of tangency of first railroad curve north of Gilbert. Elevation, 29.2797.

T. B. M. 30.—Boat spike in root of a 1-meter cow oak, on west side of Como-Gilbert road, 1.3 kilometers from Gilbert, at mouth of short side lane, and 50 meters northeast of shanty. Elevation, 28.6170.

T. B. M. 32.—Boat spike in root of a 0.2-meter sweet gum, on north side of short east and west lane on Como-Gilbert road, 2.6 kilometers from Gilbert, and 450 meters east of where road turns to south. Elevation, 28.4805.

T. B. M. 33.—Boat spike in root of a 1-meter black oak, on north side of Como-Gilbert road, at east end of lane and west edge of woods, 3.5 kilometers from Gilbert, and at northeast corner of field of George Thornburgh. Elevation, 28.9684.

T. B. M. 34.—Boat spike in root of 0.5-meter black gum on south side of Como-Gilbert road and 40 meters south of south end of short north and south lane, 5 kilometers from Gilbert. Elevation, 28.8522.

T. B. M. 35.—Boat spike in root of a 0.4-meter hickory on west side of Como-Gilbert road at a point 150 meters north of shanty on Widow Gleason's place, near where main road turns from east and west to north and south. Elevation, 29.5875.

T. B. M. 36.—Boat spike in root of a 1.5-meter cow oak on north side of Como-Gilbert road 10 meters east of bayou, 60 meters west of west end of lane, and near southwest corner of field of Armstead Haines. Elevation, 28.8876.

T. B. M. 37.—Spike in root of a 0.6-meter gum near southeast corner of Mr. Cordell's place on Como-Gilbert road, 200 meters south of junction of side road to Osbornes Ferry. Elevation, 29.5703.

T. B. M. 38.—Boat spike in root of an 0.8-meter chinaberry on east side of road on Macon front 100 meters below Mrs. Ward's residence, 400 meters above Osbornes Ferry, and 75 meters back from right bank of Bayou Maçon. Elevation, 30.0700.

P. R. P. Osborne.—Pipe-flange bench in northeast corner of front yard to residence of W. R. Osborne, at Osbornes Ferry, on Bayou Maçon, Franklin Parish, La. Bench is 21 meters from right bank of bayou. Elevation, 30.0112.

B. M. 44 (*Maçon survey, 1898*).—Wire nail in root of a 0.4-meter post oak, 22 meters from right bank of Bayou Maçon, and 30 meters above mouth of Atchafalaya Bayou. Elevation, 25.1238.

T. B. M. 40.—Boat spike in root of a 0.5-meter sweet gum on south side of road, where road forks to cross swamp to New Light. Elevation, 26.4805.

T. B. M. 46.—Boat spike in root of a 1-meter white oak on south side of road and 170 meters west of Roaring Bayou. Elevation, 23.9602.

T. B. M. 48.—Boat spike in root of a 0.5-meter pin oak, on south side of road, 100 meters from Cross Bayou, and 30 meters east of junction of old road from the north with Como-New Light road. Elevation, 25.0093.

T. B. M. 51.—Spike in root of a 0.2-meter pecan, on south side of road, 80 meters west of cabin on Myer place, and on right bank of Tensas River, opposite mouth of Mound Bayou. Elevation, 27.0857.

B. M. 39 (*Tensas survey, 1898*).—Wire nail in root of a 1-meter pin oak in yard of I. S. Osborne, on Mound Bayou place. Bench is 20 meters northeast of northeast corner of house. Elevation, 27.9391.

T. B. M. 52.—Spike in root of an 0.8-meter red elm, 30 meters south of right bank of Tensas River, and 150 meters above mouth of Mound Bayou. Elevation, 25.7851.

P. B. M. New Light.—Pipe-flange bench in the northeast corner of James R. Lynch's front yard at New Light, Tensas Parish, La., and 10 meters back from left bank of Tensas River. Elevation, 28.0417.

B. M. 38 (*Tensas Survey, 1898*).—Wire nail in root of an 0.8-meter pin oak immediately in front of and 1 meter from blacksmith shop at New Light, 10 meters from back of warehouse. Elevation, 27.3154.

SHREVEPORT TO JETERS LANDING, LA.

P. B. M. 46.—See descriptions, Camden, Ark., to Shreveport, La. (p. 1484).

P. B. M. 1.—Pipestone bench at Albany Point, Caddo Parish, La., in northeast corner of yard, 10.3 meters from northeast corner of house, 16 meters from edge of bluff, and 10 meters northwest from a cedar tree. Elevation, 74.1125.

P. B. M. 2.—Pipestone bench at Henderson Mill, Caddo Parish, La., near upper end of Soda Lake. Is on line with north side of deserted house, 10 meters from northwest corner, 28 meters from edge of bluff, 12.4 meters southeast of twin mulberry and hickory trees. Witnessed north and south by two buried millstones. Elevation, 80.6605.

P. B. M. 3.—Pipestone bench at Mooringsport, Caddo Parish, La., on north side of C. S. Croon's store, 1.9 meters from northwest corner of gallery and 0.4 meter from edge of gallery, 0.6 meter from northwest corner of wall, and 45 meters from top bank of Ferry Lake. Elevation, 62.0015.

P. B. M. 4.—Pipestone bench at Jeters Landing, Caddo Parish, La., on line of east side of deserted house, 0.9 meter from northeast corner, 21.1 meters from edge of bluff, measured on north and south line, and 29 meters from post oak on edge of bluff. Elevation, 66.3028.

JONESVILLE TO VIDALIA, LA., AND NATCHEZ, MISS.

P. B. M. 4.—See descriptions, Monroe to mouth of Black River, La. (p. 1477).

P. B. M. 3.—See descriptions, Monroe to mouth of Black River, La. (p. 1477).

Gauge B. M. A.—Large nail in root of an 18-inch hackberry 225 feet back from main bank of river and just above high-water section of gauge at Black River Station, La. Tree is blazed and the letters $^{U}{}_{A}{}^{S}$ are painted on blaze. Elevation 22.9750.

Gauge B. M. C.—Large nail in pignut hickory near United States gauge at Black River Station, La. Tree is blazed and the letters $^{U}{}_{C}{}^{S}$ are painted on blaze. Elevation, 21.0380.

Gauge B. M. B.—Is top of a large nail in root of a sweet gum near United States gauge at Black River Station, La. The bench is 46.009 feet above the zero of the gauge. The tree is blazed and the letters $^{U}{}_{B}{}^{S}$ are painted on blaze. Elevation, 21.5956.

T. B. M. 27.—See descriptions, Monroe to mouth of Black River, La. (p. 1477).

T. B. M. 20.—Nail in root of a pecan, 14 meters south of track of the Natchez, Red River and Texas Railroad, 25 meters southeast from milepost 7, and 154 meters west of trestle 56. Elevation, 23.6701.

T. B. M. 19.—Nail in root of an oak, 33 meters north of track, 80 meters east of trestle, and 25 meters from levee. Elevation, 24.2165.

T. B. M. 2.—Pipestone bench at Frogmore, Concordia Parish, La., in southwest corner of section-house yard of Natchez, Red River and Texas Railroad. Is on east bank of Otts Bayou, 10 meters north of track, and 11 meters east of trestle over Otts Bayou. Elevation, 23.3852.

T. B. M. 9.—Nail in root of a 0.5 meter cottonwood at southeast corner of cabin occupied by Nancy Vaughan on south side of road, and 6 meters from levee. Elevation by line from Rayville to Concordia, 25.7460. Elevation, 25.7884.

T. B. M. 1.—Nail in root of a 0.5 meter pecan, on east side of Trinity street, Vidalia, La., and 14 meters north of M. R. C. stone $\frac{132}{3}$. Elevation, 25.2415.

M. R. C. Stone $\frac{132}{3}$.—Pipestone bench on west side of Trinity street, Vidalia, La., 440 meters back from north line of street nearest the river, 315° 20′, 420 meters from court-house, and 194°, 448 meters from church. Elevation, 24.3034.

M. R. C. Stone $\frac{132}{4}$.—Pipestone bench on east side of Trinity street, Vidalia, La., 1,295 meters from north side of street nearest the river and parallel to it, 136 meters north of north fence around group of cabins on west side of road. Elevation, 23.8684.

C. and G. S. P. B. M. LXIII.—Bench found disturbed in 1893. At east base near Vidalia court-house. The center of cross on bolt in granite monument, 14 by 14 inches on top, projecting 14 inches above ground, situated in lot immediately back of court-house and jail, and marking the east end of the Vidalia base. Lot is owned by J. Conti, of Natchez, Miss., and stone is marked "U. S. C. S. G. P.—1875." Coast and Geodetic Survey elevation, ——. Elevation, 24.8462.

C. and G. S. P. B. M. LXII.—At Vidalia, Concordia Parish, La. Is bottom of cavity in top of a marble post near steps leading to front entrance of Judge W. H. Hough's residence. Post is on right of steps. Coast and Geodetic Survey elevation, 19.2866 meters, Gulf level. Elevation, 25.5127.

C. and G. S. P. B. M. LXI.—About a mile below Vidalia, Concordia Parish, La. The intersection of the cross lines on the top of an iron screw pile used as a triangulation station. It is situated in an open field near road to Vidalia, on right-hand side, and marked "U. S. C. S. G. P.—1875." Coast and Geodetic Survey elevation, 18.7353 meters, Gulf level. Elevation, 24.9613.

C. and G. S. P. B. M. LXIV.—At Palo Alto place, Concordia Parish, La., about a mile north of Vidalia. The center of cross on top of iron screw pile marking Boyd's triangulation station, Palo Alto, on property of Mrs. Kate Minor, of Natchez, about 250 meters to left of road from Videlia, marked "U. S. C. S. G. P.—1875." Coast and Geodetic Survey elevation, 19.7233 meters, Gulf level. Elevation, 25.9494.

B. M. 1858.—Established September 25, 1858, by William Sidney Smith. Is cross in brick next to wall, under marble sign of clerk's office, at Vidalia, La. Elevation, 25.7639.

Court-house pedestal (*Delta survey, 1858*).—On water table or pedestal, under cement, at the northeast corner of court-house building, at Vidalia, La. Delta survey elevation, 156.75 feet. Elevation, 26.4222.

B. M. Polk 2.—Cross cut in south corner of brick at southwest end of retaining wall, at corner, ninth course above ground. Bench is opposite the old Ray and Grant building at the corner of Silver and Fulton streets, Natchez, Miss. Elevation, 31.2207.

B. M. No. 3 (*Babbit, 1874*).—Is point made with chisel in corrugated iron door step in upstream face of brick building, formerly Ray and Grant's store, in rear of elevator. Elevation, 30.6834.

B. M. Ewens N.—Top of spike driven horizontally in mortar course of river face of ice house under the hill at Natchez, Miss. Bench is near downstream corner, 2.5 feet above ground, and the letter N is cut in brick near bench. Elevation, 27.8026.

B. M. Babbit (1879).—Top of stone coping at the northeast corner of State and Broadway streets, Natchez, Miss. Elevation, 65.5228.

P. B. M. 1.—Pipestone bench in the middle park on the bluffs at Natchez, Adams County, Miss., about 20 meters from east fence, near a large red oak. Is in line with the north side of Buntura alley, which is midway between and parallel with Main and State streets. Elevation, 65.6859.

Melvin, 1879.—Is on northeast corner of lower step of west entrance to court-house at Natchez, Miss. Elevation, 71.9475.

BARBIN TO MOUTH OF BLACK RIVER, LA.

T. B. M. 53.—See descriptions, Grand Bend to Smithland, La. (p. 1498).

T. B. M. 116.—Nail in root of a 0.6-meter chinaberry in front of Bordelon's store on Barbin Landing-Marksville road. It is the most northerly of a row of chinaberries in front of store. Bench is on west side of tree. Elevation, 31.1080.

T. B. M. 52.—See descriptions, Grand Bend to Smithland, La. (p. 1498).

T. B. M. 99.—Nail in root of an 0.8-meter pin oak, on east side of Barbin Landing-Marksville road at a point 100 meters north of where road comes in from Normands Landing. Elevation, 29.4982.

T. B. M. 98.—Nail in west side of cap block to second bent, from south end of highway bridge over Bayou Rouge, 600 meters south of Barbin Landing. Elevation, 23.7102.

T. B. M. 51a.—See descriptions, Grand Bend to Smithland, La. (p. 1497).

P. B. M. Barbin.—Pipe-flange bench in the back downstream corner of yard to residence at Barbin Landing, 17 meters south of gate in east fence of yard and 40 meters southwest of southwest corner of warehouse. Elevation, 23.8538.

T. B. M. 100.—Boat spike in root of a 1-meter cottonwood, 10 meters from the right bank of Red River and 25 meters below Bettevy's store. Elevation, 23.8335.

T. B. M. 101.—Nail in root of a 1-meter cottonwood, 20 meters from right bank of Red River on Samuel Gardner's place, 200 meters above where lane runs across first right-hand point below Bettevys Landing. Elevation, 23.6116.

T. B. M. 102.—Nail in root of a 0.5-meter sycamore at lower end of Samuel Gardner's place, 500 meters above Edwards Crevasse, 50 meters above shanty, 20 meters from bank of Red River, and immediately outside of small levee. Elevation, 23.5515.

T. B. M. 103.—Nail in root of a 0.9-meter cottonwood at upper end of Bettevy's place, 400 meters below Edwards Crevasse, 60 meters below shanty, and 10 meters from right bank of Red River. Elevation, 23.3370.

T. B. M. 104.—Nail in root of a 0.7-meter sycamore at upper end of Brouillette place, 150 meters below last cabin on Bettevy's place and in old field 25 meters from bank of Red River. Elevation, 23.3222.

T. B. M. 105.—Nail in root of an 0.8-meter cottonwood on Juncan's place, 75 meters below residence, 100 meters above west end of lane, through which road turns back across Saline place, 20 meters from right bank of Red River, inside of field, immediately east of small levee. Elevation, 23.5649.

T. B. M. 107.—Nail in side (not root) of an 0.8-meter leaning pecan, 18 meters south of Bayou Lenoir, 200 meters east of where road across Saline Point crosses Bayou Lenoir, and on south side of road. Elevation, 21.9056.

T. B. M. 108.—Nail in bench cut on side (not root) of a 0.3-meter leaning sycamore, 30 meters from right bank of Red River, 300 meters below where road turns across Saline Point, and 400 meters above John White's residence at north edge of road. Elevation, 22.3809.

P. B. M. White.—Pipe-flange bench in northwest corner of yard to residence of Mr. John White, 1 kilometer below lower end of Saline Point. Bench is 33 meters from right bank of Red River, 8 meters west from west end of house, and 11 meters north of north line of porch on north side (front) of house. Elevation, 22.7847.

T. B. M. 109.—Nail in bench cut on side (not root) of a 1.2-meter leaning ash on edge of right bank of Red River, 10 meters north of road, 100 meters below shanty on John White's place, and 125 meters above northeast corner of White's field. Elevation, 21.8740.

T. B. M. 112.—Nail in notch on curve in trunk of a 0.3-meter ash on west side of road to Murrays Landing, 90 meters below where a road turns to right, cutting off Murray Point. Bench is 80 meters from right bank of river. Elevation, 21.9726.

T. B. M. 113.—Nail in root of a 1.2-meter leaning willow, 20 meters from bank of Red River, 90 meters above house at Old Raccouri place, or Murray Landing on Monlard's Place. Elevation, 22.1227.

T. B. M. 114.—Nail in root of a 0.7-meter Spanish oak on back bank of Murray Lake, about 300 meters southeast of back (downstream) corner of field on the old Murray place, between lake and edge of dim road. Bench is about 200 meters above the open part of lake. Elevation, 21.4945.

T. B. M. 115.—Nail in root of a 1-meter elm, on south side of dim road, 100 meters above northeast end of Murray Lake and 75 meters from bank of lake at edge of low swamp. The dim road leads out to river at upper edge of old field about 300 meters below the bench. Elevation, 21.2301.

T. B. M. 117.—Nail in notch (not root) cut on side of an 0.8-meter leaning pecan, on east side of road, 20 meters from right bank of Red River, 500 meters below point where road turns across Murray Point and 300 meters below old field, grown up, on the Theodore place. Elevation, 21.6531.

T. B. M. 122.—Nail in notch (not root) cut on a leaning 0.8-meter willow, on left bank of Long Lake, about 1 kilometer below where the lake heads in Red River. Bench is on downstream side of road which cuts across point to mouth of Black River. Elevation, 20.9486.

T. B. M. 123.—Nail in root of a 0.4-meter post oak, on west side of road from Long Lake to mouth of Black River, on north slope of narrow ridge in swamp, and 100 meters south of south edge of pin oak flat, which is about 1.5 meters higher than swamp proper. Elevation, 19.3363.

T. B. M. 125.—Nail in root of an 0.8-meter bitter pecan, on east side of road in pin oak flat, 900 meters north of Long Lake Swamp proper. Elevation, 20.4260.

T. B. M. 126.—Nail in root of a 1-meter ash, on southeast side of road in pin oak woods, 600 meters south of Palmetto Bayou. Elevation, 20.4978.

T. B. M. 127.—Nail in root of an 0.8-meter pecan, on west side of road and 300 meters north of where road crosses Palmetto Bayou, 40 meters east of bayou and 40 meters south of sharp bend in east bank. Bench is on west side of tree. Elevation, 20.4016.

T. B. M. 128.—Nail in root of a 1.1-meter overcup oak, in fork at edge of roads where road divides to the north, the two branches running parallel for some distance, then uniting some 250 meters north of bench. Elevation, 20.2674.

T. B. M. 129.—Nail in root of a 0.9-meter pecan, on east side of road where it enters old field on river front, on Chas. Jarnett place, about 300 meters back from right bank of Red River, 100 meters below abandoned cabin, the third cabin from lower end of clearing. Elevation, 20.6065.

T. B. M. 130.—Nail in root of a 0.5-meter pin oak, on back downstream corner of clearing on Chas. Jarnett (?) place, about 2 kilometers above mouth of Black River. Bench is 130 meters from bank of Red River and 25 meters back of shanty. Elevation, 20.7332.

T. B. M. 131.—Nail in root of a 1-meter pin oak, on north side of road cutting first right-hand point below clearing on Chas. Jarnett place, and 1 kilometer along road below lower end of clearing; 75 meters south of bench is a low swamp. Elevation, 21.0188.

T. B. M. 132.—Nail in root of a 0.3-meter pin oak, 10 meters from Red River, and at right edge of small bayou running into Red River at a point 100 meters above mouth of Black River. Elevation, 21.0925.

T. B. M. 36.—See descriptions, Monroe to mouth of Black River, La. (p. 1478).

P. B. M. 12a.—See descriptions, Monroe to mouth of Black River, La. (p. 1478).

FRIARS POINT TO CLARKSDALE, MISS.

P. B. M. Friars Point II.—Center of hole in head of copper bolt leaded horizontally into a brick at northeast end of northeast wall of brick building belonging to the estate of W. H. Dickerson. Building is on the south side of Commerce Street, in block No. 2 of Fulton's addition to town of Friars Point, Coahoma County, Miss. Bolt is about 1 meter above ground and 1 meter from north corner of building. Elevation, 61.2991.

P. B. M. Friars Point III.—At Friars Point, Coahoma County, Miss. Pipe-flange bench in northeast corner of yard of H. H. Gaines, 10 meters north of north wall and 1 meter east of east wall of Gaines's house. House is on Chisim avenue, between Sycamore and Yates streets. Elevation, 59.8444.

P. B. M. Coahoma.—Pipe-flange bench 8 meters south of south wall and in line with east wall of Methodist Church. Church is a large frame house, standing almost centrally in triangle framed by the Yazoo and Mississippi Valley Railroad tracks at Coahoma, Coahoma County, Miss. Bench is 3 meters west of a 0.5-meter blazed gum. Elevation, 60.2700.

P. B. M. Clover Hill.—Pipe-flange bench in southwest corner of yard of railway section house, 1.5 kilometers north of Clover Hill, Coahoma County, Miss. Elevation, 58.8841.

P. B. M. Lyon.—Pipe-flange bench near northeast corner of Baptist Church at Lyon, Coahoma County, Miss. Church is a large frame structure about 400 meters south of depot and 200 meters west of track. Bench is in line with north wall of church and 2 meters east of east wall. Elevation, 59.0468.

T. B. M. 25.—Nail in root of a 0.5-meter elm, on west side of wagon road from Lyon to Clarksdale, 75 meters west of railroad and in front of gate where private road turns to residence. Elevation, 58.0427.

T. B. M. 26.—Nail in root of a 0.5-meter cottonwood, 8 meters west of track and 150 meters west of milepost 76. Elevation, 58.8630.

T. B. M. 27.—Nail in root of a double cottonwood in section-house yard, 65 meters west of track and 200 meters north of depot at Clarksdale. Elevation, 58.1236.

P. B. M. Clarksdale I.—Pipe-flange bench in west corner of court-house grounds, Clarksdale, Coahoma County, Miss. Bench is 18 meters northwest of line of extreme northwest wall and 39 meters southwest of line of southwest wall. Bench is N. 83° W., 41 meters of northeast corner. Elevation, 58.9994.

P. B. M. Clarksdale II.—Pipe-flange bench near south corner of main portion of section foreman's house at Clarksdale, Coahoma County, Miss. Bench is in line with southwest wall of main portion of building and 2 meters from northwest wall of same part of house. House is the most northerly of three, and 400 meters east of track. Elevation, 58.6207.

P. B. M. Clarksdale III.—Cross cut on stone cap block of northeast pier (Clarksdale side) of the Yazoo and Mississippi Valley Railroad bridge over Sunflower River. Bench is at the upstream end of pier, in line with northeast face of pedestal block, and 0.1 meter from north corner of pedestal. Bench is marked: $\overset{\text{U S}}{\underset{\text{PBM}}{+}}$. Elevation, 58.7361.

TABLE 2 A.—*Chain line.—Permanent reference lines along Ouachita and Black rivers.*

NOTE 1.—All bench-mark monuments referred to as "pipe-stone benches" consist of pieces of limestone 46 centimeters square and 15 centimeters thick, marked $\overset{\text{U S}}{\underset{\text{B M}}{\text{o}}}$ with spherical-headed copper bolts, leaded in upper faces, and buried 1.2 meters underground; access being given through 12-centimeter iron pipes set on top. Each pipe has a cast-iron cap, fastened by a horizontal bolt through cap and pipe. The cap has a small boss and letters $\overset{\text{U S E}}{\underset{\text{B M}}{\text{o}}}$ raised on top. Elevations apply to top of bolt in the underground stone. Elevation of boss of pipe cap can be found in any case by adding 1.24 meters to the elevation of copper bolt.

NOTE 2.—All bench-mark monuments referred to as "pipe-flange benches," consist of pieces of 4-centimeter gas pipe about 1.6 meters long, capped at upper end and having a 12-centimeter circular flange attached near lower end by lock nuts. Monuments are set with about 0.1 meter above ground surface. Flanges are surrounded, in the usual case, by a matrix of neat cement, approximately doubling the bearing area of the monument. Elevations apply to the top of cap.

NOTE 3.—All bench-mark monuments referred to as "pipe benches," consist of 4-centimeter gas pipes about 1.6 meters long, capped at upper end and flattened at lower end. Monument is set by driving until upper end is about 0.1 meter above ground.

All elevations are expressed in meters above the Cairo datum. Elevations by ordinary level are stopped at the second decimal place. Azimuths by topographers and distances by stadia are stopped at the nearest minute and nearest meter respectively.

When kind of monument is not stated, "pipe stone" will be understood in the case of permanent reference points, and "pipe" in the case of permanent azimuth points.

PERMANENT REFERENCE LINE ◬ 439–◬ WEST BASE (R. R. S. 1891)–MOUTH OF BLACK RIVER.

◬ *439.*—Is joint of vitrified sewer pipe filled with cement, on left second bank of Red River, 150 meters below mouth of Black River, 55 meters east of south corner of Delhoste's field fence, and 160 meters south of cabin. Elevation 20.6276.

△ *West base.*—Is joint of vitrified sewer pipe filled with cement, in field of Edmund Joffrion, 140 meters south of right bank of Red River, 77 meters north of southwest corner of field fence, and 190 meters west-southwest of cabin. Elevation 20.88; latitude 31° 15′ 23″; longitude 91° 49′ 53″; azimuth 354° 49′ 01″; distance 961.2 meters.

PERMANENT REFERENCE LINE △ 439–△ 441 (R. R. S. 1891)—MOUTH OF BLACK RIVER.

△ *439.*—See above.

△ *441.*—Is joint of vitrified sewer pipe filled with cement, in field of F. Saucier, 120 meters south of cabin, 38 meters north of fence, and 75 meters north of left bank of Red River. Elevation 21.05; azimuth 321° 05′ 30″; distance 1029.4 meters.

PERMANENT REFERENCE LINE LANIUS—3 KILOMETERS ABOVE ACME POST-OFFICE.

P. R. P.—Pipe flange 3 meters west of west fence on J. A. Lanius' place, 66 meters south of northwest corner of field, 212 meters back from river bank, and witnessed by three triangular blazed trees, as follows: 0.4-meter pecan, 13 meters, 356° 30′; 0.4-meter pecan, 10 meters, 33° 05′; 0.5-meter double honey locust, 20.5 meters, 53° 32′. Elevation, 22.06.

P. A. P.—1 meter north of fence on south side of J. A. Lanius' place, 75 meters back from right bank of river, 110 meters from southeast corner of field measured along fence on south side, and witnessed by three triangular blazed trees, as follows: 0.7-meter honey locust, 21 meters, 273° 55′; 0.5-meter pecan, 14 meters, 30° 00′; 1-meter pecan, 24 meters, 52° 15′. Azimuth, 290° 54′ 11″; distance, 898.2 meters.

PERMANENT REFERENCE LINE TRISLER—0.6 KILOMETER BELOW TRISLER LANDING.

P. R. P.—Pipe flange on mound west of Fairplay place, about 340 meters back from right bank of river, and on west edge of strip of woods between main wood line and river. Pipe is about 3 meters from west corner of mound. Elevation, 23.80.

P. A. P.—Is in northeast corner of Mrs. Birdie Trisler's field, at edge of wood line, 0.8 meter west of fence, 0.3 meter west of road leading across to John Welch's, and about 500 meters back from river, measured along road. Azimuth to first cabin toward river, 2° 52′; distance, 92 meters. Azimuth, 231° 43′ 43″; distance, 1,026.2 meters.

PERMANENT REFERENCE LINE LUM-LUMS LANDING.

P. R. P.—Same as P. B. M. 9a. See descriptions, Monroe to mouth of Black River, La. (p. 1478).

P. A. P.—Is in edge of field, 538 meters below residence occupied by H. L. Pauhl, 0.5 meter inside of fence, 4 meters east of road, and witnessed by three triangular blazed trees, as follows: 0.4-meter water oak, 11 meters, 62°; 0.3-meter pecan, 14 meters, 26°; 0.3-meter water oak, 15 meters, 310°. Azimuth, 299° 50′; distance, 526 meters.

PERMANENT REFERENCE LINE JACKSON—0.4 KILOMETER ABOVE GILLESPIE BAYOU.

P. R. P.—Pipe flange in southeast corner of Samuel Jackson's field, 4 meters back from left bank of river, 1 meter inside of fence and opposite lower end of island. Witnessed by three triangular blazed trees, as follows: 1-meter red oak, 16.5 meters, 127° 10′; 0.8-meter water oak, 5 meters, 107° 25′; 0.4-meter red oak, 6.5 meters, 340°. Elevation, 22.13.

P. A. P.—Is in southwest corner of pasture belonging to John Welch, 0.6 meter inside of fence, 300 meters back from right bank of river, 150 meters above Gillespie Bayou, and witnessed by three triangular-blazed trees, as follows: 0.4-meter double pecan, 7 meters, 179° 10′; 0.3-meter pecan, 9 meters, 62° 30′; 0.3-meter honey locust, 10.5 meters, 84° 52′. Azimuth, 25° 18′ 10″; distance, 607.7 meters.

PERMANENT REFERENCE LINE BEARD—BEARDS LANDING.

P. R. P.—Pipe flange just outside of fence, at gate leading in lot on north side of residence, and witnessed as follows: Northeast corner of store, 57 meters, 295°; northeast corner of residence, 36 meters, 359°, and three triangular-blazed trees, as follows: 0.6-meter honey locust, 26 meters, 206°; 1-meter post oak, 50 meters, 173°; 0.4-meter chinaberry, 19 meters, 330°. Elevation, 22.82.

P. A. P.—Is at east corner of cabin occupied by Jim Saden (1896), on Mrs. M. J. Beard's place. Cabin is third from river and just back from bank of lake. Azimuth, 124° 37′; distance, 372 meters.

PERMANENT REFERENCE LINE CALHOUN-MONTGOMERY-CALHOUN LANDING.

P. R. P. Calhoun.—Same as P. B. M. 7a. (See descriptions, Monroe to mouth of Black River, La., p. 1478).

P. A. P. Montgomery.—On north side of road, 373 meters, along road, from right bank of river, 100 meters east from southeast corner of field fronting on river, and opposite Calhoun Landing. Witnessed by three triangular-blazed trees, as follows: 0.8-meter water oak, 10 meters, 305° 50′; 0.3-meter pecan, 17 meters, 35° 00′; 0.4-meter pecan, 13 meters, 202° 05′. Azimuth, 278° 08′ 40″; distance, 641.9 meters.

PERMANENT REFERENCE LINE ALTON-ALTON LANDING.

P. R. P.—Pipe flange in front of Alton place, about 1 meter inside of fence, about 287 meters below Alton Landing, 13 meters from left bank of river, and witnessed by three triangular-blazed trees, as follows: 0.5-meter honey locust, 20.5 meters, 314° 30′; 0.5-meter honey locust, 34 meters, 272° 30′; 0.4-meter honey locust, 28 meters, 241° 30′. Elevation, 23.00; latitude, 31° 26′ 51″; longitude, 91° 48′ 45″.

P. A. P.—Is 200 meters back from back fence on Alton place, about 800 meters from left bank of river, 1 meter to right of road leading from Alton Landing, and witnessed by three triangular blazed trees, as follows: 0.4-meter double pecan, 16 meters, 154° 35′; 0.4-meter pecan, 40 meters, 17° 20′; 0.5-meter post oak, 29 meters, 220° 45′. Azimuth, 24° 56′ 33″; distance, 1,227.4 meters.

PERMANENT REFERENCE LINE PLOUDEN—MOUTH OF PLOUDEN BAYOU.

P. R. P.—Pipe flange on south side of lane dividing C. B. Burley, jr.'s, and Mrs. S. B. Hoyt's places, also townships 5 and 6 north, range 7 east. Is on left bank of river, 170 meters north of Plouden Bayou, and 37 meters from west end of lane. Elevation, 22.70.

P. A. P.—Is on north side of same lane as above. Is on left bank of river, 150 meters north of Plouden Bayou, and 5 meters west of east end of lane. Blazed locust is 9 meters, 280°. Azimuth, 269° 42′; distance, 515 meters.

PERMANENT REFERENCE LINE MONTGOMERY—MONTGOMERY LANDING.

P. R. P.—Pipe flange on south side of road leading west from Montgomery Landing, 1 meter north of fence on Montgomery's place, 350 meters west from right bank of river, and witnessed by three triangular blazed trees, as follows: 0.5-meter honey locust, 23 meters, 131° 30′; 0.4-meter elm, 16 meters, 195° 00′; 0.3-meter water oak, 13 meters, 75° 30′. Elevation, 22.53.

P. A. P.—Is on north side of road (373 meters along road), east of right bank of river, 100 meters east from southeast corner of field, fronting on river opposite Calhouns Landing, and witnessed by three triangular-blazed trees, as follows: 0.8-meter water oak, 10 meters, 305° 50′; 0.3-meter pecan, 17 meters, 35° 00′; 0.4-meter pecan, 13 meters, 202° 05′. Azimuth, 90° 10′ 36″; distance, 557.8 meters.

PERMANENT REFERENCE LINE JONES—JONES OR CUT-OFF BAYOU.

P. R. P.—Same as P. B. M. 5a. See descriptions, Monroe to mouth of Black River, Louisiana (p. 1477).

P. A. P.—Is at northwest side of grove in yard of Mrs. Laura Jones, 550 meters above mouth of Jones Bayou, 80 meters back from right bank of river, 25 meters back from road, and 100 meters northeast of residence. Grove consists of four rows of trees running normal to river, and P. A. P. is on upstream row, witnessed by three triangular blazed trees, as follows: 0.8-meter pecan, 8 meters, 295°; 0.7-meter sycamore, 10 meters, 9°; 0.8-meter pecan, 12 meters, 53°. Azimuth, 138° 47′ 42″; distance, 588.8 meters.

PERMANENT REFERENCE LINE GILLESPIE-JONESVILLE, 1.5 KILOMETERS ABOVE TRINITY.

P. R. P. Gillespie.—Pipe flange on upper side of Gillespie place, 1.5 meters inside of cultivated field, about 240 meters back from right bank of river and 175 meters east of wood line. Azimuth to southwest corner of house, 232° 51′. Elevation, 23.69.

P. A. P. Jonesville.—Is on large mound in Jonesville, about 350 meters from Black River, and 250 meters from Little River. Azimuth to spire of Catholic Church in Trinity, 214° 52′ 30″. Azimuth, 346° 52′ 41″; distance, 1,400.2 meters.

PERMANENT REFERENCE LINE WATSON—OUTLET OF TEW LAKE.

P. R. P.—Pipe flange on upper side of Watson place, about 30 meters south of wood line, about 500 meters back from right bank of river, about 250 meters south from deep ravine from Tew Lake, 10 meters inside fence, and witnessed by three triangular blazed trees, as follows: 0.8-meter water oak, 20.5 meters, 113° 25′; 0.8-meter red oak, 32 meters, 146° 19′; 1-meter water oak, 38 meters, 189° 30′. Elevation, 23.70.

P. A. P.—Is at lower end of meadow on Watson place, about 70 meters north of woods, 80 meters back from right bank of river, and witnessed by three triangular-blazed trees, as follows: 0.4-meter persimmon, 30 meters, 225° 25′; 0.4-meter cottonwood, 47 meters, 332° 15′; 0.6-meter water oak, 65 meters, 21° 42′. Azimuth, 348° 17′ 02″; distance, 1,171.8 meters.

PERMANENT REFERENCE LINE BUSHLEY—MOUTH OF BUSHLEY BAYOU.

P. R. P.—Pipe flange about 200 meters south of mouth of Bushley Bayou, at edge of wood line, about 325 meters back from right bank of river, and witnessed by three triangular blazed trees, as follows: 0.4-meter maple, 18 meters, 352° 30′; 0.3-meter pecan, 21 meters, 14° 00′; 1-meter cypress, 6 meters, 265° 45′. Elevation, 24.20; latitude, 31° 44′ 32″; longitude, 91° 48′ 56″.

P. A. P.—About midway of old Scott place, on large mound (first near river above Bushley Bayou) about 140 meters back from right bank of river, and witnessed by three triangular blazed trees, as follows: 0.2-meter honey locust, 8 meters, 340° 45′; 0.2-meter sweet gum, 13 meters, 110° 20′; 0.4-meter sweet gum, 19 meters, 240° 05′. Azimuth, 155° 43′ 12″; distance, 1,087.0 meters.

PERMANENT REFERENCE LINE CATAHOULA—CATAHOULA SHOALS.

P. R. P.—Same as P. B. M. 7. See descriptions, Monroe to mouth of Black River, La., (p. 1477).

P. A. P.—Is 1 meter outside of fence on west side of Purcell's place, about 275 meters back from right bank of river, about opposite lower end of Catahoula Shoals, and witnessed by three triangular blazed trees, as follows: 0.5-meter post oak, 24 meters, 103° 35′; 0.6-meter water oak, 31 meters, 68° 35′; 0.6-meter post oak, 39.5 meters, 44° 10′. Azimuth, 145° 01′ 51″; distance, 501.3 meters.

PERMANENT REFFERENCE LINE STAFFORD—STAFFORDS POINT.

P. R. P.—Same as P. B. M. 8. (See descriptions, Monroe to mouth of Black River, La. (p. 1476).

P. A. P.—Is on lower side of field at Staffords Point, about 2.5 meters inside of fence, 69 meters from main left bank of river, and witnessed by three triangular blazed trees, as follows: 1-meter water oak, 33 meters, 2° 30′; 0.5-meter red oak, 13.5 meters, 60° 35′; 0.4-meter red oak, 26.5 meters, 91° 30′; also corner of old house below field, 82 meters, 359° 20′. Azimuth 47° 40′ 33″; distance, 432.5 meters.

PERMANENT REFERENCE LINE TWIN RIVERS—2.3 KILOMETERS ABOVE ALLIGATOR LANDING.

P. R. P.—Pipe flange on right bank of Boeuf River, 9.8 kilometers above its mouth, 4.6 kilometers above mouth of Turkey Creek, and witnessed by three triangular blazed trees, as follows: 0.4-meter pignut hickory, 16 meters, 309° 15′; 0.3-meter pignut hickory, 1.5 meters, 78° 45′; 0.4-meter overcup oak, 26 meters, 227°15′. Elevation, 21.16.

P. A. P.—Is 5 meters east of left bank of Ouachita River, 250 meters below small bayou, about 500 meters below bight of "Short Drive Bend," and witnessed by three triangular-blazed trees, as follows: 0.4-meter water oak, 4 meters, 75° 00′; 0.4 meter water oak, 16 meters, 331° 15′; 0.4-meter water oak, 8 meters, 207° 00′. Azimuth, 90° 48′; distance, 1,018 meters.

PERMANENT REFERENCE LINE DAVIS—I. N. DAVIS LANDING.

P. R. P.—Pipe flange on upper side of old Davis place, 0.7 meter inside of fence around cultivated field, about 100 meters east of woodline, 170 meters back from right bank of river, and witnessed by three triangular-blazed trees, as follows: 0.1-meter persimmon, 7 meters, 158° 30′; 0.2-meter post oak, 35.8 meters, 255° 35′; 0.2-meter persimmon, 5.9 meters, 64° 15′. Elevation, 24.10.

P. A. P.—Is on lower side of Davis place, 5 meters inside of fence around cultivated field, 60 meters back from right bank of river, and witnessed by three triangular-blazed trees, as follows: 0.5-meter overcup oak, 8 meters, 223° 25′; 0.9-meter post oak, 27 meters, 306° 05′; 0.8-meter red oak, 28 meters, 48° 15′; also southeast corner of cabin near northeast corner of field, 75 meters, 141° 05′. Azimuth, 289° 40′ 48″; distance, 923.8 meters.

PERMANENT REFERENCE LINE YOUNG—0.7 KILOMETER BELOW PETERS BAYOU.

P. R. P.—Pipe flange on south side of old field on old Cody place, on edge of main left bank of river, 105 meters above old house, and witnessed by three triangular blazed trees, as follows: 0.3-meter pecan, 20 meters, 56° 45′; 0.6-meter pecan (branching into 3 limbs about 2.5 meters above ground), 32.3 meters, 299° 15′; 0.4-meter pecan, 29.7 meters, 329° 40′. Elevation, 25.32.

P. A. P.—Is on south side of old Young place, at edge of woods, about 400 meters back from right bank of river, 200 meters from north fence, and witnessed by three triangular-blazed trees, as follows: 0.2-meter double sweet gum, 5.4 meters, 340° 15′; 0.7-meter black gum, 16.9 meters, 324° 50′; 0.3-meter water oak, 7.8 meters, 251° 05′. Azimuth, 311° 50′ 33″; distance, 684.8 meters.

PERMANENT REFERENCE LINE COTTINGHAM—COTTINGHAM LANDING.

P. R. P.—Same as P. B. M. 14. See descriptions, Monroe to mouth of Black River, La. (p. 1476).

P. A. P.—Is in edge of woodline. about 450 meters back from river, about 300 meters above cultivated field, 130 meters east of road running on edge of low bottom, and witnessed by three triangular-blazed trees, as follows: 0.8-meter water oak, 15 meters, 98° 40′; 0.8-meter water oak, 25 meters, 209° 20′; 0.5-meter post oak, 8 meters, 28° 15′. Azimuth, 43° 43′ 26″; distance, 324.0 meters.

PERMANENT REFERENCE LINE KING—COLES LANDING.

P. R. P.—Same as P. B. M. 13. See descriptions, Monroe to mouth of Black River, La. (p. 1476).

P. A. P.—Is in woods just north of old King place, about 88 meters north of fence line, about 37 meters east of road which runs on west side of field fence; about 50 meters east of slough on west side of road, 640 meters from river, and witnessed by three triangular-blazed trees, as follows: 0.8-meter water oak, 17.3 meters, 163°; 0.8-meter water oak, 8.6 meters, 192°; 0.4-meter sweet gum, 17.7 meters, 280°. Azimuth, 204° 29′ 07″; distance, 639.4 meters.

PERMANENT REFERENCE LINE GIBSON—GIBSONS LANDING.

P. R. P.—See descriptions, Monroe to mouth of Black River, La. (p. 1476).

P. A. P.—Is on edge of left second bank and 150 meters from left third bank of river, opposite Gibsons Landing. Witnessed by two triangular blazed trees as follows: 0.7-meter pin oak, 88 meters, 357°; 0.5-meter pin oak, 37 meters, 123°. Azimuth, 285° 09′; distance, 397 meters.

PERMANENT REFERENCE LINE WADE—0.6 KILOMETER BELOW WADE LANDING.

P. R. P.—See descriptions, Archibald to Bellevue and Three Rivers (p. 1511).

P. A. P.—Is in woods on south side of Wade place, about 600 meters south of fence, 550 meters east of road, 850 meters back from left bank of river, and witnessed by three triangular blazed trees, as follows: 0.4-meter red oak, 7.7 meters, 156° 35′; 0.5-meter water oak, 3.1 meters, 315° 10′; 0.6-meter water oak, 5.3 meters, 146° 50′. Azimuth, 311° 23′ 33″; distance, 1,430 meters.

PERMANENT REFERENCE LINE COLUMBIA—MOUTH OF BRIDGER BAYOU.

P. R. P.—See descriptions, Archibald to Bellevue and Three Rivers (p. 1511). Latitude 32° 6′ 16″; longitude 92° 05′ 05″.

P. A. P.—Is about 1.5 meters north of fence forming south boundary of Cicero Fluid's place, 7.5 meters north of road, 550 meters back from left bank of river, 30 meters east from first cabin from river, and witnessed by three triangular blazed trees, as follows: 0.5-meter sweet gum, 19.5 meters, 356° 45′; 0.3-meter locust, 6.8 meters, 310° 00′; 0.3-meter locust, 6.4 meters, 109° 05′. Azimuth, 94° 49′ 06″; distance, 1,811.6 meters.

PERMANENT REFERENCE LINE UPPER BRESTON–UPPER BRESTON LANDING.

P. R. P.—Pipe flange in first lane south of residence on Upper Breston place, about 130 meters back from river, 320 meters from railroad, and 0.8 meter from fence on north side of lane. Elevation, 27.21.

P. A. P.—Is 2.46 meters east of center line of railroad, and about 2 meters south of fence on north side of Upper Breston place. Azimuth, 227° 37′ 33″; distance, 507.4 meters.

PERMANENT REFERENCE LINE SINOPE–SINOPE LANDING.

P. R. P.—Pipe flange at southeast corner and on south side of fence around orchard and vegetable garden near Filhiol's residence, 135 meters back from left bank of river and nearly southeast of residence. Elevation, 27.44.

P. A. P.—Is on Sinope place, about 116 meters west of railroad, near intersection of tangents of curve on that place and about 30 meters south of plantation road running along wire fence nearly normal to railroad. Azimuth, 323° 27′ 11″; distance, 324 meters.

PERMANENT REFERENCE LINE BLANKSTON–0.9 KILOMETER ABOVE WAVERLY LANDING.

P. R. P.—Same as P. B. M. 10. See descriptions, Monroe to mouth of Black River, La. (p. 1475).

P. A. P.—Pipe flange back of third cabin above lane dividing Waverly and Hopewell places, on Hopewell place, and 465 meters east of Blankston store. Azimuth, 281° 29′; distance, 466 meters.

PERMANENT REFERENCE LINE COCO–ABOUT 1 KILOMETER ABOVE WACO LANDING.

P. R. P.—Pipe flange at west end of lane between J. B. Calvin's and Mrs. Ella Morgan's places, on left bank of river, 2 meters from southwest corner of fence and 60 meters from Methodist church. Elevation, 28.97.

P. A. P.—Is about 84 meters from east end of lane dividing Captain Grady's and R. M. Filhiol's places, about 120 meters from left bank of river and 300 meters above Horseshoe Lake. Azimuth, 269° 45′; distance, 1,261 meters.

PERMANENT REFERENCE LINE BOSCO–BOSCO LANDING OR CUBA POST-OFFICE.

P. R. P.—Pipe flange in corner of fence, formed by fence on north side of lane and short fence to southeast corner of Cuba post-office, 50 meters from left bank of river and 8.5 meters from southeast corner of post-office. Elevation, 28.21; latitude, 33° 32′ 16″; longitude, 92° 07′ 33″.

P. A. P.—Is on north side of road leading out from river crossing railroad just north of Bosco station, 1.9 meters east of main track, 2.1 meters west from side track, 3 meters north of center of dirt road, and about 388 meters back from river. Azimuth, 277° 59′ 01″; distance, 338.2 meters.

PERMANENT REFERENCE LINE LOGTOWN–LOGTOWN LANDING.

P. R. P.—Same as P. B. M. 9. See descriptions, Monroe to mouth of Black River, La. (p. 1475).

P. A. P.—Is on R. M. Filhiol's place, just above Logtown, about 1 meter south of plantation road, 16 meters west of railroad track, about 480 meters south of lane dividing Filhiol and Croton Grove places, and about 930 meters back from river. Reference point, spire of Logtown church, 50° 05′; azimuth, 211° 30′ 08″; distance, 1,015.0 meters.

PERMANENT REFERENCE LINE FILHIOL–0.7 KILOMETER BELOW BAYOU LAPINE.

P. R. P.—Pipe flange on north side and west end of lane forming north boundary of Refugio place, in angle formed by road in lane and road along river, about 27 meters back from left bank of river, and about 10 meters from road along river, and about 280 meters above bight of big right-hand bend. Elevation, 29.66.

P. A. P.—Is on north side of lane forming north boundary of Refugio place, about 650 meters from river, 5.4 meters from fence on south side of lane, and 2.4 meters east from center of railroad track. Azimuth, 266° 35′ 24″; distance, 612.9 meters.

PERMANENT REFERENCE LINE BROOKS—ABOUT 1.6 KILOMETERS ABOVE CHENIERE CREEK.

P. R. P.—Pipe flange in yard to cabin occupied by Allen Hester (1895) on Charles and Wiley Brook's place. Cabin is at southwest end of last lane across "Thirteen-mile Bend," and monument is 8 meters northwest of cabin and 4 meters northwest of underground cistern. Elevation, 29.95.

P. A. P.—Is at northwest corner of fence at northeast corner of last lane across "Thirteen-mile Bend." Azimuth, 213° 44′; distance, 294 meters.

PERMANENT REFERENCE LINE TERRY—1.2 KILOMETERS BELOW BURNHAM LANDING.

P. R. P.—Pipe flange about 100 meters back from left bank of river, 3 meters from road normal to river, and 1 meter south of fence forming north boundary of Terry place. Elevation, 30.18; latitude, 32° 26′ 24″; longitude, 92° 08′ 33″.

P. A. P.—Pipe flange 1.55 meters east of center of railroad, 159 meters south of lane and road dividing Chaffe and Terry places, and about 518 meters back from river. Azimuth, 291° 01′ 19″; distance, 534.8 meters.

PERMANENT REFERENCE LINE MONROE—DE SIARD STREET, MONROE.

P. R. P.—Section of iron rail, T cross section, sunk about 0.03 meter below surface at west end of De Siard street, about 28 meters from river bank, on line of and 3.84 meters from cross cut on Merchants and Farmers' Bank and 8.7 meters from cross cut on Block Building. Cross cut on bank building is 9.36 meters from northeast brick corner of building; cross cut on Block Building is 14.32 meters from front line of building. Reference point, cross cut on stone cap of last pier of bridge, west end, downstream side, 78° 33′ 30″. Elevation, 30.83.

P. A. P.—Section of iron rail, T cross section, sunk about 0.03 meter below surface, on De Siard street, 5.6 meters from iron fence of cemetery, and 30.5 meters from northwest corner of fence. Reference points: Spire of Methodist church (colored), 225° 01′ 05″; index finger on monument to Margaret J. Henderson, 9° 32′ 05″; spire First Baptist church (colored), 121° 56′ 02″. Azimuth, 232° 52′ 47″; Distance, 956 meters.

PERMANENT REFERENCE LINE PARGOUD-MONROE—MOUTH OF BAYOU DE SIARD.

P. R. P. Pargoud.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1468).

P. A. P. Monroe.—See above. Azimuth, 346° 36′ 58″; distance, 5,334.5 meters.

PERMANENT REFERENCE LINE D'ARBONNE-PARGOUD—MOUTH OF BAYOU D'ARBONNE.

P. R. P. D'Arbonne.—Pipe flange 340 meters from right bank of river, 52 meters from right bank of Bayou D'Arbonne, 10 meters from right bank of first side bayou up D'Arbonne, and witnessed by three triangular blazed trees, as follows: Pin oak, 15 meters, 4° 25′; sweet gum, 12 meters, 93° 50′; white oak, 8 meters, 73° 15′. Elevation, 29.03.

P. R. P. Pargoud.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1468). Azimuth, 301° 40′ 42″; distance, 2,546± meters.

PERMANENT REFERENCE LINE ZEPH—OUTLET OF ZEPH LAKE.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1468).

P. A. P.—In southeast corner of yard of Chas. Gardner (colored), 39 meters from bank of River Styx, and about 600 meters from its mouth. Azimuth, 12° 21′ 03″; distance, 889.3 meters.

PERMANENT REFERENCE LINE ROCK ROW—ROCK ROW SHOALS.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1468).

P. A. P.—Is in northeast corner of yard around first cabin above Mrs. Baker's residence and 22 meters back from right bank of river. Azimuth, 5° 40′ 46″; distance, 466 meters.

PERMANENT REFERENCE LINE GLENDORA–HUGH YOUNG LANDING.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1468).

P. A. P.—Is about 58 meters from fence on south side of Glendora place, on edge of small strip of woods, about 2,200 meters back from river, and witnessed by three triangular blazed trees, as follows: 0.4-meter sweet gum, 16 meters, 293° 20′; 0.5-meter water oak, 9 meters, 328° 50′; 0.5-meter sweet gum, 36 meters, 358° 10′. Azimuth, 281° 10′ 33″; distance, 2,047.4 meters.

PERMANENT REFERENCE LINE OUACHITA-PARKEVILLE–OUACHITA CITY.

P. R. P. Ouachita.—Top of cap of 2½-inch gas pipe with flange, set vertically in ground near southeast corner of frame store building of J. A. Peek. Bench is 1 meter north of south wall, 0.9 meter east of east wall, about 20 meters south of Main street, and about 80 meters back from right bank of river. Elevation, 32.07.

P. R. P., Parkeville.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1469). Azimuth, 282° 33′ 04″; distance, 716± meters.

PERMANENT REFERENCE LINE CASHILL–MOUTH OF MILL BAYOU.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1469).

P. A. P.—Is 170 meters from river bank, about 260 meters below road to Cashill Landing, and witnessed by three triangular-blazed trees, as follows: 0.7-meter post oak, 2 meters, 197°; 0.5-meter post oak, 19 meters, 259° 35′; 0.6-meter post oak, 13 meters, 356° 40′. Azimuth, 3° 56′ 21″; distance, 1,128.8 meters.

PERMANENT REFERENCE LINE FISHTRAP–LOWER END OF FISHTRAP SHOALS.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1469).

P. A. P.—Is about 200 meters back from river, 800 meters below old road, and witnessed by three triangular-blazed trees, as follows: 0.4-meter water oak, 12 meters, 269° 40′; 0.4-meter water oak, 6 meters, 211° 45′; 0.5-meter post oak, 2 meters, 73° 55′. Azimuth, 203° 39′ 0.9″; distance, 896.4 meters.

PERMANENT REFERENCE LINE ALABAMA–ALABAMA LANDING.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p.1469). Latitude, 32° 51′ 57″; longitude, 92° 07′ 02″.

P. A. P.—Is about 10 meters from left bank of Bachèlor Pierre Creek, about 70 meters from river, and witnessed by three triangular-blazed trees, as follows: 0.5-meter water oak, 17 meters, 88° 30′; 0.5-meter water oak, 9 meters, 201° 45′; 0.5-meter water oak, 5 meters, 309° 40′. Azimuth, 332° 17′ 34″; distance, 635.7 meters.

PERMANENT REFERENCE LINE FRANK PIERRE–FRANK PIERRE CREEK.

P. R. P.—See descriptions Monroe, La., to Little Rock, Ark. (p.1469).

P. A. P.—Is about 122 meters back from right bank of river, 550 meters above small bayou, and witnessed by three triangular-blazed trees, as follows: 0.3-meter post oak, 5 meters, 222° 35′; 0.4-meter post oak, 12 meters, 228° 05′; 0.5-meter post oak, 18 meters, 15° 20′. Azimuth, 189° 13′ 55″; distance, 936.6 meters.

PERMANENT REFERENCE LINE SHILOH–SHILOH SHOALS.

P. R. P.—See descriptions Monroe, La., to Little Rock, Ark. (p. 1469).

P. A. P.—Is about 250 meters back from right bank of river, just opposite head of Mallard Shoals, and witnessed by three triangular-blazed trees, as follows: 0.4-meter post oak, 20 meters, 198° 45′; 0.4 meter post oak, 3 meters, 307° 15′; 0.7-meter post oak, 7 meters, 82° 15′. Azimuth, 6° 42′ 39″; distance, 905.2 meters.

PERMANENT REFERENCE LINE STATE LINE–ARKANSAS-LOUISIANA STATE LINE.

P. R. P.—Pipe flange 89 meters back from right bank of river, 600 meters below small cabin on left bank, and witnessed by three triangular blazed trees, as follows: 0.8-meter white oak, 9 meters, 340°; 0.5-meter white oak, 2 meters, 50°; 0.6-meter white oak, 12 meters, 151°. Elevation, 25.86.

P. A. P.—Is 39 meters back from left bank of river, and witnessed by three triangular blazed trees, as follows: 0.5-meter white oak, 10 meters, 138°; 0.9-meter white oak, 21 meters, 220°; 0.7-meter white oak, 24 meters, 6°. Azimuth, 270° 02′; distance, 269 meters.

PERMANENT REFERENCE LINE LAKE—LAKE ST. MARY.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1469).

P. A. P.—Is about 130 meters from left bank of Lake St. Mary, about 180 meters below small slough running into lake, about 400 meters above canal connecting river and lake, and witnessed by three triangular blazed trees, as follows: 0.6-meter post oak, 14 meters, 66° 25′; 0.4-meter post oak, 8 meters, 272° 30′; 0.6-meter post oak, 14 meters, 339° 45′. Azimuth, 151° 41′ 34″; distance, 875.2 meters.

PERMANENT REFERENCE LINE LAPILE—1.6 KILOMETERS ABOVE BAYOU LAPILE.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1470).

P. A. P.—Is about 530 meters back from right bank of river, and 110 meters east of Fishtrap Lake, which is an enlargement of Bayou Lapile. Witnessed by three triangular blazed trees, as follows: 0.3-meter post oak, 4 meters, 84° 25′; 0.5-meter post oak, 10 meters, 212° 05′; 0.7-meter sweet gum, 6.5 meters, 299° 50′. Azimuth, 192° 20′ 59″; distance, 726.9 meters.

PERMANENT REFERENCE LINE MARIE SALINE—MARIE SALINE LANDING.

P. R. P.—Is 307 meters back from left bank of river, 10 meters north of road from landing, and witnessed by three triangular blazed trees, as follows: 0.5-meter white oak, 38 meters, 54° 30′; 0.6-meter white oak, 32 meters, 317°; 0.7-meter pecan, 23 meters, 196° 45′. Elevation, 25.37.

P. A. P.—Is 25 meters back from right bank of river, south of ferry landing, and witnessed by three triangular blazed trees, as follows: 0.9-meter white oak, 5 meters, 326°; 0.6-meter bitter pecan, 17 meters, 217°; 0.4-meter white oak, 19 meters, 130°. Azimuth, 100° 48′; distance, 494 meters.

PERMANENT REFERENCE LINE BELLE POINT—OUACHITA BELLE LANDING.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1470). Latitude, 33° 09′ 24″; longitude, 92° 12′ 24″.

P. A. P.—Is about 600 meters below landing, 20 meters from right bank of small bayou, 200 meters from river, and witnessed by three triangular blazed trees, as follows: 0.3-meter black gum, 11 meters, 85°; 0.6-meter water oak, 12.5 meters, 12° 30′; 0.5-meter sweet gum, 5 meters, 292°. Azimuth, 318° 20′ 17″; distance, 505.3 meters.

PERMANENT REFERENCE LINE CANEY MARIE—CANEY MARIE LANDING.

P. R. P.—About 35 meters from right bank of river, 20 meters west of small drain. Elevation, 27.13.

P. A. P.—Is about 80 meters back from left bank of river, on north bank of small drain, and 10 meters east from road. Azimuth, 204° 22′; distance, 230 meters.

PERMANENT REFERENCE LINE EUTAW—0.5 KILOMETER BELOW EUTAW SHOALS.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1470).

P. A. P.—Is about 400 meters from river below old road, and witnessed by three triangular blazed trees, as follows: 0.6-meter water oak, 5 meters, 69°; 0.4-meter post oak, 6 meters, 164°; 0.4-meter post oak, 14 meters, 260°. Azimuth, 53° 22′ 28″; distance, 387.2 meters.

PERMANENT REFERENCE LINE JACKS ISLAND—JACKS ISLAND.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1470).

P. A. P.—Is 450 meters back from river and just below old road. Witnessed by three triangular blazed trees, as follows: 0.6-meter red oak, 10 meters, 70°; 0.3-meter white oak, 6 meters, 201°; 0.7-meter pine, 16 meters, 281°. Azimuth, 2° 59′ 29″; distance, 362.2 meters.

PERMANENT REFERENCE LINE CAREYVILLE–CAREYVILLE LANDING.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1470).

P. A. P.—Is on east side of road to New London, 550 meters back from river, 250 meters south of southeast corner of fence, and witnessed by three triangular blazed trees as follows: 0.2-meter red oak, 3.5 meters, 246° 50′; 0.3-meter pine, 12.3 meters, 265° 10′; 0.4-meter sweet gum, 5.6 meters, 310° 40′. Azimuth, 27° 19′ 44″; distance, 448.6 meters.

PERMANENT REFERENCE LINE PIGEON HILL–PIGEON HILL LANDING.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1470). Latitude, 33° 16′ 26″; longitude, 92° 23′ 24″.

P. A. P.—Is 94.6 meters back from left bank of river, just opposite Pigeon Hill Landing, and witnessed by three triangular-blazed trees, as follows: 0.4-meter mulberry, 5 meters, 10°; 0.3-meter sweet gum, 3 meters, 300°; 0.5-meter pin oak, 5 meters, 210°. Azimuth, 186° 08′ 42″; distance, 362.1 meters.

PERMANENT REFERENCE LINE FLETCHER–FLETCHER LANDING.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1470).

P. A. P.—Is about 185 meters back from right bank of river, 280 meters above small slough, and witnessed by three triangular-blazed trees, as follows: 0.5-meter water oak, 8.8 meters, 64° 22′; 0.3-meter sweet gum, 6.4 meters, 237° 06′; 0.5-meter water oak, 6.3 meters, 273° 02′. Azimuth, 281° 01′ 40″; distance, 528.5 meters.

PERMANENT REFERENCE LINE FRANKLIN–MOUTH OF FRANKLIN BAYOU.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1470).

P. A. P.—Is about 339 meters below Franklin Bayou, and 26 meters back from right bank of river. Azimuth, 319° 18′ 46″; distance, 514.5 meters.

PERMANENT REFERENCE LINE BELL FIELD–5.6 KILOMETERS BELOW CHAMPAGNOLLE.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1470).

P. A. P.—Is about 610 meters back from right bank of river, and witnessed by three triangular-blazed trees, as follows: 0.5-meter sweet gum, 4 meters, 290°; 0.5-meter sweet gum, 6 meters, 108°; 0.5-meter post oak, 3 meters, 52°. Azimuth, 115° 45′ 45″; distance, 556.6 meters.

PERMANENT REFERENCE LINE CHAMPAGNOLLE–CHAMPAGNOLLE.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1471). Latitude, 33° 18′ 39″; longitude, 92° 32′ 04″.

P. A. P.—Is on south side of small lake just opposite Champagnolle Landing, about 120 meters back from river, and 70 meters west of where road crosses head of lake. Azimuth, 158° 33′; distance, 333 meters.

PERMANENT REFERENCE LINE ELDORADO–ELDORADO LANDING.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1471).

P. A. P.—Is in woods, about 540 meters above Eldorado Landing, about 400 meters back from river, about 300 meters back from main bank of Eldorado Lake, and witnessed by three triangular blazed trees, as follows: 0.4-meter water oak, 1.8 meters, 224° 55′; 0.3-meter water oak, 10.5 meters, 339° 40′; 0.4-meter water oak, 5.5 meters, 40° 20′. Azimuth, 134° 17′ 55″; distance, 539.4 meters.

PERMANENT REFERENCE LINE SMACKOVER–MOUTH OF SMACKOVER CREEK.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1471).

P. A. P.—Is about 44 meters back from right bank of creek, 400 meters above its mouth, 300 meters back from right bank of river, and witnessed by three triangular blazed trees, as follows: 0.5-meter white oak, 12.5 meters, 167°; 0.9-meter white oak, 23.2 meters, 310° 30′; 1.4-meter white oak, 10.8 meters, 358° 10′. Azimuth, 50° 13′ 27″; distance, 281.2 meters.

PERMANENT REFERENCE LINE LEPPARD–LEPPARD'S CAMP.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1471).

P. A. P.—Is about 250 meters back from right bank of river, about 30 meters above small drain, and witnessed by three triangular-blazed trees, as follows: 1-meter white oak, 20.5 meters, 202° 40′; 1-meter sweet gum, 11 meters, 292° 20′; 0.8-meter hickory, 17.5 meters, 60° 35′. Azimuth, 61° 04′ 03″; distance, 431.9 meters.

PERMANENT REFERENCE LINE LITTLE BAY–MOUTH OF LITTLE BAY.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1471).

P. A. P.—Is about 60 meters back from right bank of river, about 100 meters below bight of first bend below Little Bay, 120 meters below small drain, and witnessed by three triangular blazed trees, as follows: 0.3-meter holly, 10.5 meters, 207°; 0.3-meter overcup oak, 9 meters, 268° 25′; 0.2-meter holly, 8.5 meters, 355° 35′. Azimuth, 6° 54′ 24″; distance, 767.8 meters.

PERMANENT REFERENCE LINE BEECH HILL–BEECH HILL.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1471).

P. A. P.—Is about 200 meters below where hills meet river bank, at foot of hills, 75 meters below bight of bend, 22 meters back from right bank of river, and witnessed by three triangular blazed trees, as follows: 0.3-meter sweet gum, 3 meters, 272° 15′; 0.3-meter sycamore, 4.5 meters, 30° 10′; 0.3-meter maple, 9 meters, 86° 25′. Azimuth, 312° 57′ 58″; distance, 373.7 meters.

PERMANENT REFERENCE LINE WALNUT HILL–WALNUT HILL.

P. R. P.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1471). Latitude, 33° 27′ 16″; longitude, 92° 45′ 23″.

P. A. P.—Is about 800 meters below Spoon Camp Shoals, 13 meters back from right bank of river, 125 meters south of large drain, and witnessed by three triangular blazed trees, as follows: 0.4-meter holly, 14.3 meters, 48° 10′; 0.7 meter sweet gum, 18 meters, 134° 50′; 0.3-meter elm, 18.7 meters, 175° 30′. Azimuth, 171° 03′ 59″; distance, 454.6 meters.

PERMANENT REFERENCE LINE FRENCHPORT–FRENCHPORT LANDING.

P. R. P. Frenchport II.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1471).

P. A. P.—Is in woods back of old field, in bottom, just below Frenchport, 250 meters east of small field, 300 meters back from river, and witnessed by three triangular blazed trees, as follows: 0.2-meter ironwood, 2.5 meters, 108° 45′; 0.3-meter pine, 7 meters, 248° 40′; 0.8-meter hickory, 4 meters, 348° 25′. Azimuth, 276° 57′ 22″; distance, 269.9 meters.

PERMANENT REFERENCE LINE PEDRON—PEDRON'S WOOD YARD.

P. R. P.—Is about 60 meters back from right bank of river, 15 meters from left bank of deep gully, 10 meters from old railroad track, and witnessed by three triangular blazed trees, as follows: 0.4-meter pine, 24.9 meters, 131° 25′; 0.3-meter sweet gum, 22.2 meters, 236° 20′; 0.7-meter mulberry, 11.5 meters, 355°. Elevation, 37.35.

P. A. P.—Is cross cut on top of section of railroad rail, about 26 meters south of log road leading west into woods, about 27 meters west of railroad, 11 meters west of old track, 63 meters northwest of cabin, and witnessed by three triangular blazed trees, as follows: 0.3-meter double red oak, 19.1 meters, 64° 50′; 0.3-meter red oak, 7.2 meters, 5° 25′; 0.2-meter pine, 31.5 meters, 284° 50′. Azimuth, 137° 16′ 49″; distance, 363.4 meters.

PERMANENT REFERENCE LINE TREADAWAY—TREADAWAY LANDING.

P. R. P.—In yard of residence at Treadaways, 1.6 kilometers below Camden, near southwest corner of brick smokehouse and 15 meters west of residence. Elevation, 41.25.

P. A. P.—Is on prolongation of fence on east side of farmhouse yard of Mr.

Thornton. Reference points are as follows: Point of suspension of balances of figure of Justice on Camden court-house, 121° 40′; 0.3-meter chinaberry, 15 meters, 0° 42′; northeast corner of stable, 20 meters, 49° 15′; northeast corner of farmhouse, 49 meters, 17°. Azimuth, 93° 42′ 24″; distance, 505 meters.

PERMANENT REFERENCE LINE CAMDEN—CAMDEN, ARK.

P. R. P. Camden III.—See descriptions, Monroe, La., to Little Rock, Ark. (p. 1472). Latitude, 33° 34′ 56″; longitude, 92° 51′ 10″.

P. A. P.—Destroyed.

TABLE 2 B.—*Chain line.—Comparison of observed and carried azimuths.*

Locality.	Azimuth.						Discrepancy.		Number of intermediate stations.
	Observed.			Carried.					
	°	′	″	°	′	″	′	″	
Mouth of Black River, La	321	05	30	321	06	08	0	38	33
Altons Landing, La	152	40	00	152	39	34	0	26	17
Jonesville, La	166	52	39	166	53	23	0	44	14
Bayou Bushley, La	23	17	15	23	16	40	0	35	28
Youngs Landing, La	247	18	36	247	20	28	1	52	28
Columbia, La	193	09	21	193	10	52	1	31	22
Terry Place, La	111	01	29	111	02	58	1	29	23
Bayou Lonewa, La	93	34	33	93	35	22	0	49	32
Alabama Landing, La	100	30	01	100	30	21	0	20	12
Shiloh Shoals, Ark	221	05	04	221	04	15	0	49	82
Belle Point, Ark	217	01	06	217	02	53	1	47	34
Pigeon Hill, Ark	253	52	12	253	51	32	0	40	34
Champagnolle, Ark	295	43	50	295	45	24	1	34	40
Walnut Hill, Ark	110	57	54	110	58	31	0	37	83
Camden, Ark	163	28	53	Initial.			....	....	....

TABLE 2 C.—*Chain line.—Azimuths and lengths of permanent reference lines.*

[Azimuths are given from the P. R. P.'s to the P. A. P.'s, and each azimuth is referred to the meridian of its P. R. P. Each meridional convergence is that obtaining between the P. R. P. of line immediately preceding and that of line standing opposite. Azimuths and lengths determined by stadia line are given to nearest minute and meter, respectively.]

Name of line.	Distance from mouth of Black River.	Azimuth.			Length.	Meridional convergence.	
	Kilometers.	°	′	″	*Meters.*	′	″
△439–△West Base	0.0	[a]354	49	01	961.2	....	....
△439–△441	0.0	[a]321	05	30	1,029.4	....	....
Lanius	6.7	290	54	11	898.2	—0	49
Trisler	16.2	231	43	43	1,026.2	+0	19
Lum	25.0	299	50		526	+2	08
Jackson	32.6	25	18	10	607.7	—2	10
Beard	41.4	124	37		372	—0	13
Calhoun-Montgomery (P. A. P.)	47.2	278	08	40	641.9	+1	11
Alton	50.6	24	56	33	1,227.4	+0	16
Plouden	61.4	269	42		515	+2	50
Montgomery	71.0	90	10	36	557.8	—2	43
Jones	82.9	138	47	42	588.8	—0	09
Gillespie-Jonesville (P. A. P.)	92.9	346	52	41	1,400.2	0	00
Watson	103.9	348	17	02	1,171.8	+0	17
Bushley	114.6	155	43	12	1,087	—0	09
Catahoula	123.7	145	01	51	501.3	+0	56
Stafford	130.4	47	40	33	432.5	—0	07
Twin Rivers	138.1	90	48		1,018	—0	27
Davis	141.1	289	40	48	923.8	—1	08
Young	151.2	311	50	33	684.8	—1	48
Cottingham	159.5	43	43	26	324	—1	17
King	168.2	204	29	07	639.4	—1	15
Gibson	178.5	285	09		397	—1	36
Wade	189.4	311	23	33	1,430	+0	05
Columbia	198.6	94	49	06	1,811.6	—0	54
Upper Breston	213.2	227	37	33	507.4	—1	28
Sinope	224.6	323	27	11	324	—0	35
Blankston	228.7	281	29		466	—0	29

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[a] By Red River survey of 1891, reduced from meridian of △ West Base to that of △ 439.

TABLE 2 C.—*Chain line.—Azimuths and lengths of permanent reference marks*—Cont'd.

Name of line.	Distance from mouth of Black River.	Azimuth.			Length.	Meridional convergence	
	Kilometers.	°	′	″	*Meters.*	′	″
Coco	239.6	269	45		1,261	−0	23
Bosco	249.2	277	59	01	338.2	+1	37
Logtown	258.5	211	30	08	1,015.0	−0	36
Filhiol	263.8	266	35	24	612.9	−0	17
Brooks	275.3	213	44		294	−0	58
Terry	284.1	291	01	19	534.8	+1	15
Monroe	294.5	232	52	47	956	−0	17
Pargoud-Monroe (P. A. P.)	301.7	346	36	58	5,334.5	−0	09
Pargoud-D'Arbonne (P. R. P.) [a]	301.7	121	40	42	2,546	+1	02
Zeph	313.3	12	21	03	889.3	+1	02
Rock Row	322.4	5	40	46	466	−0	47
Glendora	330.7	281	10	33	2,047.4	+0	08
Parkeville-Ouachita (P. R. P.)[a]	338.8	102	33	04	716	+1	43
Cashill	346.0	3	56	21	1,128.8	−0	06
Fishtrap	354.4	203	39	09	896.4	−0	09
Alabama	360.6	332	17	34	635.7	+0	31
Frank Pierre	366.1	189	13	55	936.6	+0	04
Shiloh	374.1	6	42	39	905.2	−0	09
State Line	380.5	270	02		269	+0	31
Lake	388.1	151	41	34	875.2	−1	26
Lapile	397.0	192	20	59	726.9	−0	55
Marie Saline	405.5	100	48		494	+1	17
Belle Point	414.9	318	20	17	505.3	−2	14
Caney Marie	424.3	204	22		230	−0	13
Eutaw	430.1	53	22	28	387.2	−1	26
Jacks Island	445.5	2	59	29	362.2	+2	02
Careyville	451.3	27	19	44	448.6	−0	40
Pigeon Hill	458.2	186	08	42	362.1	−1	36
Fletcher	466.2	281	01	40	528.5	−1	11
Franklin	474.9	319	18	46	514.5	−2	17
Bell Field	487.1	115	45	45	556.6	−1	05
Champagnolle	490.5	158	33		333	−0	41
Eldorado	494.1	134	17	55	539.4	−0	22
Smackover	501.5	50	13	27	281.2	−1	17
Leppard	510.5	61	04	03	431.9	−1	27
Little Bay	519.2	6	54	24	767.8	−1	03
Beech Hill	527.6	312	57	58	373.7	−2	08
Walnut Hill	534.3	171	03	59	454.6	−0	35
Frenchport	543.4	276	57	22	269.9	−0	59
Pedron	549.3	137	16	49	363.4	−0	40
Treadaway	563.8	93	42	24	505	−1	13
Camden	568.0	Destroyed.			....	....	

TABLE 2 D.—*Chain line.—Permanent reference lines along tributaries.*

TENSAS RIVER.

PERMANENT REFERENCE LINE GILLESPIE-JONESVILLE–1.5 KILOMETERS ABOVE TRINITY.

See permanent reference lines along Ouachita River, p. 1518.

PERMANENT REFERENCE LINE STANTON–STANTON STATION.

P. R. P.—Pipe flange about 75 meters north of Natchez, Red River and Texas Railroad track, about 250 meters south of left bank of Tensas River, on Athlone place, and about 40 meters west of bayou or lake near platform for cotton east of Stanton station. Elevation, 23.20.

P. A. P.—Is in corner of fence, 20 meters from left bank of Tensas River, on Athlone place, and 410 meters northwest of P. R. P. Stanton. Azimuth, 124° 56′; distance, 410 meters.

PERMANENT REFERENCE LINE CLAYTON–CLAYTON.

P. R. P.—See descriptions, Rayville to Concordia, La., p. 1508.

P. A. P.—Is in yard of cabin, 50 meters back from right bank of river, 10 meters south from cabin on fence line, and 25 meters west from railroad track. Azimuth 139° 16′ 37″; distance, 243 meters.

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[a] Azimuth is from first P. R. P. named.

PERMANENT REFERENCE LINE TENSAS–O. K. LANDING.

P. R. P.—See descriptions, Rayville to Concordia, La., p. 1507.

P. A. P.—Is smoke stack of gin at northeast corner of O. K. place. Azimuth, 329° 17′; distance, ——.

PERMANENT REFERENCE LINE MOUTH OF MAÇON–MOUTH OF BAYOU MAÇON.

P. R. P.—Pipe flange in front of cabin on Johnson place, 45 meters southwest from the junction of Bayou Maçon with Tensas River; 6 meters back from right top bank of Bayou Maçon, and witnessed by two triangular-blazed trees, as follows: 0.18-meter black locust, 9 meters, 112° 30′; 0.30-meter hackberry, 6 meters, 35° 20′.

P. A. P.—Is on edge of left top bank of Tensas River, opposite mouth of Bayou Maçon, and witnessed by two triangular-blazed bitter pecan trees. Azimuth, 269° 41′ 42″; distance, 878 meters.

PERMANENT REFERENCE LINE KINGS CAMP–KINGS CAMP.

P. R. P.—Head of 6-penny nail in root of a 0.3-meter elm, on left top bank of Tensas River at Kings old stave camp. Tree has three blazes.

P. A. P.—Is head of 6-penny wire nail in center blaze of three blazes on 0.4-meter white oak. Azimuth, 251° 23′.

PERMANENT REFERENCE LINE NEW LIGHT–NEW LIGHT.

P. R. P.—Head of 6-penny nail in root of a 0.7-meter white oak on north side of road leading to New Light. Tree has three blazes.

P. A. P.—Is extreme top, at northwest corner, of brick chimney to gin on Pecan place, owned by John Lynch. Azimuth, 303° 26′.

PERMANENT REFERENCE LINE DALLAS–DALLAS.

P. R. P.—Same as P. B. M. 9. See descriptions, Delta to Coushatta, La. (p.1491).

P. A. P.—Is a railroad bench mark, a + cut in end of rail sunk vertically in ground on south side of track and opposite station at Dallas. Azimuth, 95° 43′; distance, 322 meters.

BAYOU MAÇON.

PERMANENT REFERENCE LINE MOUTH OF BAYOU MAÇON–MOUTH OF BAYOU MAÇON.

See permanent reference lines along Tensas River, above, on this page.

PERMANENT REFERENCE LINE CUT-OFF–MOUTH OF CUT-OFF BAYOU.

P. R. P.—Pipe flange on knoll west of warehouse at mouth of Cut-off Bayou; under and west of 0.15-meter pin oak, 12 meters northwest of northwest corner of warehouse, 40 meters west of right bank of Bayou Maçon, 50 meters north of left bank of Cut-off Bayou, and 20 meters east of fence. Elevation, 27.04.

P. A. P.—Is pipe flange about 50 meters back from left top second bank, and 3 meters back from main bank, opposite Cut-off Landing, and is witnessed by four triangular-blazed trees, as follows: 0.8-meter sweet gum, north 10.2 meters; 0.8-meter sweet gum, east 11.6 meters; 0.8-meter sweet gum, south 13.7 meters, and 0.4-meter pin oak, west 7.9 meters. Azimuth, 273° 25′ 07″; distance, 224 meters.

PERMANENT REFERENCE LINE OSBORNE–OSBORNE LANDING.

P. R. P.—See descriptions, Gilbert to New Light, La., (p. 1512).

P. A. P.—Is pipe flange, about 12 meters south of right top bank of bayou, 320 meters east of residence of W. R. Osborne, 1 meter south of fence, and about 60 meters east of where fence goes to river bank. Azimuth, 255° 40′ 59″; distance, 304 meters.

PERMANENT REFERENCE LINE NEWCOMER–SUNRISE LANDING.

P. R. P.—See descriptions, Delhi to Tensas River, La., via Warsaw Landing and Bayou Maçon (p. 1505).

P. A. P.—Is pipe flange on inner slope of levee, opposite Sunrise Landing, about 15 meters back from left top bank of bayou and 225 meters north of gin on India place. Azimuth, 266° 23′ 14″; distance, 269 meters.

PERMANENT REFERENCE LINE DELHI-NEAR DELHI.

P. R. P.—One and one-half inch galvanized-iron pipe, flush with surface, without cap or flange, on top of railway embankment, 2.30 meters south of center of track, 3.95 meters west-northwest of "stop" post at west end of trestle approach over Bayou Maçon.

P. A. P.—One and one-half inch pipe without cap or flange, in northeast corner of garden attached to yard around house of Samuel Matthews (colored); about 17 meters northeast of northeast corner of cabin, 20 meters south of railroad track, 410 meters east of station platform, 0.65 meter south of north fence of garden, and 1.13 meters west of east fence. Azimuth, 94° 25′ 17″; distance, ——.

PERMANENT REFERENCE LINE EPPS-EPPS FERRY.

P. R. P.—One and one-half inch gas pipe, flush with ground, on river side of slope of levee, in line with downstream side of store at Epps Ferry, and 13 meters from west corner.

P. A. P.—Steam pipe about center of gin on Mayburn place, right bank of bayou, at Epps Ferry, and 40 meters south of road. Azimuth, 123° 37′.

P. A. P., No. 2.—Steam pipe on gin on Epps place, left bank of bayou and about 100 meters south of ferry. Azimuth, 48° 42′.

PERMANENT REFERENCE LINE FLOYD-NEAR FLOYD.

P. R. P.—One and one-half inch gas pipe with sleeve at upper end, about 400 meters below Floyd, on Mrs. Emma White's place, 150 meters west of river bank, 10 meters west of edge of hills, about 200 meters southeast of Mr. Dorset's house, 27 meters north of fence, and 44 meters south of cabin.

P. A. P.—Tip of court-house cupola in Floyd. Azimuth, 161° 45′ 44″.

BŒUF RIVER.

PERMANENT REFERENCE LINE STAFFORD-STAFFORDS POINT.

See permanent reference lines along Ouachita River, p. 1519.

PERMANENT REFERENCE LINE TWIN RIVERS-2.3 KILOMETERS ABOVE ALLIGATOR LANDING.

See permanent reference lines along Ouachita River, p. 1519.

PERMANENT REFERENCE LINE DE SHA-SMITH PLACE.

P. R. P.—Pipe flange 13 meters from edge of left bank at De Sha Landing on the Smith place, 7 meters on an azimuth of 117° from deserted cabin at landing, and witnessed by two triangular-blazed trees, as follows: 0.6-meter water oak, 2 meters, 59°; 0.3-meter gum, 8.5 meters, 258°. Elevation, 25.80.

P. A. P.—Nail in root of a 0.5-meter pignut hickory on right top second bank. Tree has triangular blaze. Azimuth, 308° 31′; distance, 180 meters.

PERMANENT REFERENCE LINE DALY-DALY LANDING.

P. R. P.—Pipe flange, 21 meters from left bank. Northeast corner of warehouse at landing is 17 meters, 90° 20′; 1.4 meters-water oak with triangular blaze and letters "U S" is 4 meters, 70°. Elevation, 26.39.

P. A. P.—Nail in root of 0.4-meter triangular-blazed pin oak. Azimuth, 105° 15′; distance, 94 meters.

PERMANENT REFERENCE LINE LONG REACH.

P. R. P.—Pipe flange on concave side of bend, 10 meters from edge of right top bank, about 100 meters above bight of bend, and witnessed by three triangular-blazed trees, as follows: 0.1-meter pecan, 2 meters, 248°; 0.1-meter pignut hickory, 5 meters, 310°; 0.6-meter overcup oak, 12 meters, 37°. Elevation, 19.64.

P. A. P.—Nail in root of a 0.1-meter triangular-blazed pignut hickory, 3 meters from right top bank and about 100 meters below bight of bend. Azimuth, 209° 51′; distance, 274 meters.

PERMANENT REFERENCE LINE WHITE OAK–WHITE OAK LANDING.

P. R. P.—Pipe-flange on top of ridge at White Oak Landing, 48 meters east of landing, 18 meters from edge of bank, and witnessed by three triangular-blazed trees, as follows: 0.4-meter sweet gum, 5 meters, 317° 30′; 0.3-meter white oak, 5.5 meters, 298°; 0.3 meter elm, 1.5 meters, 128°. Elevation, 24.35.

P. A. P.—Nail in root of a 0.6-meter pin oak, 8 meters from edge of left top bank and 237 meters above White Oak Landing. Tree has letters "U S" blazed on it. Azimuth, 232° 20′; distance, 210 meters.

PERMANENT REFERENCE LINE THREE RIVERS–THREE RIVERS FERRY.

P. R. P.—See descriptions, Archibald to Bellevue and Three Rivers, La. (p. 1511).

P. A. P.—Nail in root of a 0.4-meter water oak, about 45 meters north of Winsboro-Columbia road and 133 meters west from right bank of river. Azimuth, 75° 04′; distance, 108 meters.

PERMANENT REFERENCE LINE JOES BAYOU–JOES BAYOU.

P. R. P.—Pipe flange 11 meters back from right top bank of river, 400 meters above head of Joes Bayou, and witnessed by three triangular-blazed trees, as follows: 0.4-meter post oak, 4 meters, 273°; 0.2-meter post oak, 11 meters, 6° 30′; 0.3-meter post oak, 11 meters, 184°. Elevation, 21.88.

P. A. P.—Nail in root of a 0.4-meter red oak 4 meters from edge of right top bank. Azimuth, 203° 34′; distance, 442 meters.

PERMANENT REFERENCE LINE GUM POINT–GUM POINT LANDING.

P. R. P.—Pipe flange 7 meters back from left top bank of river 5 meters from Liddieville road and 10 meters north from north corner of warehouse at landing. Elevation, 24.57.

P. A. P.—Nail in root of a triangular blazed tree 14 meters from left top bank of river and about same distance west of road to Liddieville. Azimuth, 221° 03′; distance, 260 meters.

PERMANENT REFERENCE LINES OMEGA AND WILDERNESS–BIG CREEK.

P. R. P. Omega.—Nail in root of tree. Elevation, 21.64.

P. A. P. Omega.—Nail in root of 0.7-meter red oak 27 meters from left top bank.

P. A. P. Wilderness.—Nail in root of 0.2-meter overcup oak, 13 meters from left top bank.

P. R. P. Omega to P. A. P. Omega, 217° 49′; distance, 117 meters.
P. R. P. Omega to P. A. P. Wilderness, 206° 54′; distance, 139 meters.
P. A. P. Omega to P. A. P. Wilderness, 163° 31′; distance, 32 meters.

PERMANENT REFERENCE LINE OVERFLOW–BIG CREEK.

P. R. P.—Pipe flange on point opposite mouth of Big Creek, 8 meters from edge of point, 6 meters from bank of chute, and 6 meters from Boeuf River. Elevation, 22.74.

P. A. P.—Nail in root of a 0.4-meter oak on left top bank of river. Azimuth, 35° 43′; distance, 294 meters.

PERMANENT REFERENCE LINE MUDDY BAYOU–MUDDY BAYOU.

P. R. P.—Pipe flange on left top bank of Muddy Bayou and Boeuf River, and witnessed by three triangular-blazed trees as follows: 0.2-meter overcup oak, 3.4 meters, 114°; 0.25-meter overcup oak, 2.7 meters, 227°; 0.3-meter overcup oak, 4.3 meters, 336°. Elevation, 23.20.

P. A. P.—Nail in root of a triangular-blazed 0.8-meter red oak on left bank of Muddy Bayou. Azimuth, 182° 48′; distance, 173 meters.

PERMANENT REFERENCE LINE HEBERT–LAFOURCHE–HEBERT PLACE.

P. R. P. Hebert and P. R. P. Lafourche.—See descriptions, Archibald to Bellevue and Three Rivers, La. (p. 1510). Azimuth, 347° 47′; distance, 213 meters.

PERMANENT REFERENCE LINE DUFF-DUFF PLACE.

P. R. P.—Pipe flange on river side of fence in front of Duff place (formerly known as Roberts place), 4 meters west of right top bank of river and 56 meters northeast of J. L. Duff's cabin. Elevation, 25.78.

P. A. P.—Same as wye level bench 89. Nail in root of 1-meter sweet gum on edge of right top bank of bayou, 20 meters west of right top bank of river, 75 meters north of northeast corner of field of Duff place, and 250 meters north of cabin. Tree has triangular blaze. Elevation, 24.94. Azimuth, 196° 23′; distance, 160 meters.

PERMANENT REFERENCE LINE WHEELER-IRVING PLACE.

P. R. P.—See descriptions, Archibald to Bellevue and Three Rivers, La. (p. 1510).

P. A. P.—Wire nail in root of a 1.2-meter pin oak on right top bank of river on the Irving place, 380 meters above cabin, and 70 meters southeast of public road. Azimuth, 237° 59′ 07″; distance, 370 meters.

PERMANENT REFERENCE LINE HARRIS-HARRIS PLACE.

P. R. P.—See descriptions, Archibald to Bellevue and Three Rivers, La. (p. 1509).

P. A. P.—Pipe flange in southwest corner of J. J. Harris's back yard, and 8 meters from southwest corner of house. Azimuth, 191° 22′; distance, 669 meters.

PERMANENT REFERENCE LINE ELMORE-DOUCIER-DOUCIER PLACE.

P. R. P. Elmore and P. R. P. Doucier.—See descriptions, Archibald to Bellevue and Three Rivers, La. (p. 1509). Azimuth, 66° 16′; distance, 532 meters.

PERMANENT REFERENCE LINE NOBLE 2-DR. NOBLE'S PLACE.

P. R. P.—See descriptions, Archibald to Bellevue and Three Rivers, La. (p. 1509).

P. A. P.—Pipe flange in northeast corner of pasture of Dr. Noble's place, and 200 meters from left top bank of river where road comes across neck from the Mackintosh place. Azimuth, 298° 17 ; distance, 169 meters.

PERMANENT REFERENCE LINE HATCH-HOLLY GROVE LANDING.

P. R. P.—See descriptions, Archibald to Bellevue and Three Rivers, La. (p. 1509).

P. A. P.—Pipe flange in fence corner of field back of residence of Frank Hatch, and 100 meters east of cabin occupied by Charles Williams. Azimuth. 345° 22′; distance, 241 meters.

PERMANENT REFERENCE LINE STOKES-STOKES PLACE.

P. R. P. and P. A. P.—See descriptions, Archibald to Bellevue and Three Rivers, La. (p. 1509). Azimuth, 49° 43′; distance, 301 meters.

PERMANENT REFERENCE LINE ALTO-ALTO.

P. R. P.—See descriptions, Archibald to Bellevue and Three Rivers, La. (p. 1508).

P. A. P.—Pipe flange on south side of road, Alto to Archibald, 0.5 meter from fence and about midway between two cabins on John Hemler's place and 300 meters from left top bank of river at lower part of Alto. Azimuth, 272° 54′; distance, 279 meters.

PERMANENT REFERENCE LINE GIRARD-GIRARD.

P. R. P.—Center of railroad track, opposite and in line with east wall of railroad depot at Girard.

P. A. P.—Center of track over mudsill at west end of trestle leading to drawbridge across river. Azimuth, 275° 12′; distance, 664 meters.

PERMANENT REFERENCE LINE WHITE ISLAND-NEW ORLEANS AND NORTHWESTERN BRIDGE.

P. R. P.—West rail over mudsill at north end of trestle approach to drawbridge of the New Orleans and Northwestern Railway across Boeuf River.

P. A. P.—West rail over mudsill at south end of trestle of the New Orleans and Northwestern Railway across Old River. Azimuth, 355° 23′; distance, 520 meters.

BAYOU D'ARBONNE.

PERMANENT REFERENCE LINE D'ARBONNE-PARGOUD—MOUTH OF BAYOU D'ARBONNE.

See permanent reference lines along Ouachita River, p. 1522.

BAYOU BARTHOLOMEW.

PERMANENT REFERENCE LINE OUACHITA-PARKEVILLE—OUACHITA CITY.

See permanent reference lines along Ouachita River, p. 1523.

PERMANENT REFERENCE LINE SANDIDGE—SANDIDGE PLACE.

P. R. P.—See descriptions, Parkeville, La., to Greenville, Miss., via Arkansas City, Ark. (p. 1484).

P. A. P.—Nail in root of an 0.8-meter post oak, triangular blazed, 2 meters north of road, 450 meters from right top bank of bayou where Ouachita City road comes from Bastrop through lane on Sandidge place. Azimuth, 88° 11′; distance, 435 meters.

PERMANENT REFERENCE LINE MEYERS—MEYERS PLACE.

P. R. P.—See descriptions, Parkeville, La., to Greenville, Miss., via Arkansas City, Ark. (p. 1484).

P. A. P.—Nail in root of a 0.5-meter black gum, 4 meters from northeast corner of lodge and 20 meters west of road. Azimuth, 64° 11′; distance, 300 meters.

PERMANENT REFERENCE LINE WILLIAMS—JONES PLACE.

P. R. P.—See descriptions, Parkeville, La., to Greenville, Miss., via Arkansas City, Ark. (p. 1484).

P. A. P.—Nail in root of triangular blazed 0.3-meter black locust, 9 meters west of right top bank, 2 meters west of road and 4 meters from point where fence crosses it. Azimuth, 30° 19′; distance, 174 meters.

PERMANENT REFERENCE LINE ROSS—POINT PLEASANT LANDING.

P. R. P.—Center of cavity in gin shaft on left top bank, 4 meters west of road from Ouachita City to Bastrop. Witnessed as follows: Northwest corner of stable on Ross place, 16 meters, 300°; northwest corner of residence on Ross place, 83 meters, 223°. Monument marks line of Speaker and Ross places, also Point Pleasant Landing.

P. A. P.—Nail in root of a 1-meter sycamore, at edge of Ouachita City and Bastrop road, and 60 meters from end of lane where said road passes through Ross place. Azimuth, 199° 30′; distance, 220 meters.

PERMANENT REFERENCE LINE ANDERSON—ANDERSONS FORD.

P. R. P.—See descriptions, Parkerville, La., to Geeenville, Miss., via Arkansas City, Ark. (p. 1484).

P. A. P.—Nail in root of triangular blazed 1.2-meter red oak, 4 meters, on river side, from right top bank, and 50 meters north of cabin on Jones place. Azimuth, 153° 57′, distance, 151 meters.

PERMANENT REFERENCE LINE BONNER—BONNER PLACE.

P. R. P.—See descriptions, Parkeville, La., to Greenville, Miss., via Arkansas City, Ark. (p. 1484).

P. A. P.—Nail in root of a triangular blazed 1.2-meter red oak, 32 meters from edge of right top bank, 25 meters from center of road, and 12 meters from cabin on Bonner place. Azimuth, 103° 47′; distance, 133 meters.

PERMANENT REFERENCE LINE ROUND TURNS—BONNERS FERRY.

P. R. P.—Pipe flange on right top bank of bayou, 6 meters from center of road where it turns down to Bonners Ferry, at beginning of Malloy bend and end of the series of bends called "The Round Turns," 35 meters, 259° 40′ from cabin of Jim Williams on the Bonner place and in corner of wire fence to field, and 10 meters from corn crib. Elevation, 35.00.

P. A. P.—Pipe flange, 12 meters from edge of right top bank of bayou, 1 meter inside of fence around field on Bonner place, and 60 meters southeast of cabin. Azimuth, 215° 28′; distance, 711 meters.

PERMANENT REFERENCE LINE DAVIS 2–WARDS PLACE.

P. R. P.—See descriptions, Parkeville, La., to Greenville, Miss., via Arkansas City, Ark. (p. 1485).

P. A. P.—Pipe flange, about 20 meters from right top bank of bayou, near lower end of strip of woods between J. S. Bussey and R. H. Ward places. Azimuth, 67° 41′; distance, 307 meters.

PERMANENT REFERENCE LINE WARD–WARDS FERRY.

P. R. P.—See descriptions, Parkeville, La., to Greenville, Miss., via Arkansas City, Ark. (p. 1485).

P. A. P.—Nail in root of a triangular blazed 0.5-meter sweet gum, on edge of right top bank, 2½ meters from center of road and 6 meters from fence around field of H. H. Hope. Azimuth, 115° 38′; distance, 194 meters.

PERMANENT REFERENCE LINE WELLS–WELLS PLACE.

P. R. P.—See descriptions, Parkeville, La., to Greenville, Miss., via Arkansas City, Ark. (p. 1485).

P. A. P.—Nail in root of a triangular-blazed 0.5-meter sweet gum, 19 meters from left top bank of bayou where road leaves bayou to cross the point, 5 meters from center of road, and 30 meters from west end of Mrs. T. O. Level's field. Azimuth, 274° 02′; distance, 223 meters.

PERMANENT REFERENCE LINE MOUNDS–MOUNDS LANDING.

P. R. P.—See descriptions, Parkeville, La., to Greenville, Miss., via Arkansas City, Ark. (p. 1485).

P. A. P.—Nail in root of a triangular-blazed 0.3-meter post oak, 20 meters from fence around pasture, 35 meters south of end of hills, and 30 meters south of road. Azimuth, 15°; distance, 209 meters.

PERMANENT REFERENCE LINE LINDGROVE–LINDGROVE LANDING.

P. R. P.—See descriptions, Parkeville, La., to Greenville, Miss., via Arkansas City, Ark. (p. 1485).

P. A. P.—Nail in root of triangular-blazed 1.2-meter cow oak, 5 meters from center of lane, where Bonita road passes through Huff place, and opposite to and 75 meters from north end of Huff residence. Azimuth, 266° 15′; distance, 209 meters.

PERMANENT REFERENCE LINE SHADY GROVE–HUFF PLACE.

P. R. P.—Pipe flange in corner of fence on south side of road to Jones, where road enters lane after leaving bayou, 5 meters from center of road, 227 meters from left top bank of bayou, and 170 meters from cabin occupied by Wiley Jackson (colored) on the Huff place. Elevation, 37.48.

P. A. P.—Nail in root of triangular-blazed 1-meter white oak, 73 meters from left top bank. Azimuth, 148° 46′; distance, 154 meters.

PERMANENT REFERENCE LINE HORSESHOE–HUGHES FORD.

P. R. P.—Pipe flange 29 meters from left top bank of bayou, 15 meters from left top bank of lower arm of Horseshoe Lake, in outside corner of fence about field on Ivey place, and 4 meters from center of road at angle where road leaves bayou and goes up lake. Elevation, 38.89.

P. A. P.—Nail in root of triangular-blazed 0.4-meter water oak, about 60 meters north from cabin on the Ivey place, occupied by Jim Curtis (colored), about 75 meters west from bank of Horseshoe Lake, and 75 meters west from northeast corner of Ivey field. Elevation, 38.84; azimuth, 108° 50′; distance, 61 meters.

PERMANENT REFERENCE LINE LOUISIANA-ARKANSAS-LOUISIANA AND ARKANSAS STATE LINE.

P. R. P.—See descriptions, Parkeville, La., to Greenville, Miss., via Arkansas City, Ark. (p. 1486).

P. A. P.—Nail in root of tree on east bank of bayou, about 500 meters south of State line (measured along road), and about 100 meters northwest of Houston, Central Arkansas and Northern Railway, at a point 50 meters southwest of first dirt road crossing track below State line. Azimuth, 117° 20′; distance, 123 meters.

PERMANENT REFERENCE LINE NOBLE 1-NOBLE PLACE.

P. R. P.—See descriptions, Parkeville, La., to Greenville, Miss., via Arkansas City, Ark. (p. 1486).

P. A. P.—Nail in root of triangular-blazed 0.5-meter sycamore, about 20 meters east of edge of left top bank of bayou, and about 75 meters west of railroad. Elevation, 40.98; azimuth, 31° 37′; distance, 201 meters.

PERMANENT REFERENCE LINE MORRIS-MORRIS PLACE.

P. R. P.—Pipe flange 3 meters west of left top bank of bayou, 2 meters east of road, in outside corner of worm fence around field of John Morris, and about 70 meters northwest of cabin occupied by Charlie Covington (colored), on the Morris place. Elevation, 42.43.

P. A. P.—Nail in root of triangular-blazed 1.4-meter pine, about 10 meters east of edge of left top bank of bayou, about 75 meters south of cabin occupied by Charlie Covington (colored), on the Morris place, and about 7 meters southeast from southwest corner of field. Elevation, 42.71; azimuth, 344° 25′; distance, 140 meters.

PERMANENT REFERENCE LINE M'BRIDE-M'BRIDE PLACE.

P. R. P.—Pipe flange 33 meters from left top bank of bayou, 1 meter inside of downstream corner of fence around field of Arthur McBride, and 4 meters from center of Portland-Hamburg road at point of junction of said road with road coming up bayou. Elevation, 44.44.

P. A. P.—Nail in root of triangular-blazed 1.2-meter red oak, 6 meters west of road and 170 meters east of left top bank of bayou. Azimuth, 158° 48′; distance, 417 meters.

PERMANENT REFERENCE LINE KITRELL-ROBERT PUGH'S PLACE.

P. R. P.—Pipe flange 23 meters from left top bank of bayou, 1 meter inside of fence, 15 meters from corner, in angle of road to Montrose, 8 meters from north and south leg, 18 meters from east and west leg, and on line with and about midway between two cabins, one inside and the other outside of fence. Elevation, 44.76.

P. A. P.—Nail in root of triangular-blazed 0.6-meter cow oak, on left top bank of bayou and right top bank of slough. Azimuth, 12° 17′; distance, 158 meters.

PERMANENT REFERENCE LINE MORRELL-MORRELL.

P. R. P.—See descriptions, Parkeville, La., to Greenville, Miss., via Arkansas City, Ark. (p. 1487).

P. A. P.—Northwest corner of most westerly chimney of depot at Morrell. Azimuth, 26° 52′.

PERMANENT REFERENCE LINE COX-NEAR COX FORD.

P. R. P.—Pipe flange in southeast corner of fence around church and schoolhouse on lane between Louis Belchior's and Mrs. Mattie Cox's places, 5 meters north of center of lane and 5 meters northeast of well in same inclosure. Church is known as Silver Mount Baptist Church. Elevation, 46.48.

P. A. P.—Nail in root of triangular-blazed 0.5-meter black locust, 4 meters from left top bank of bayou, 80 meters below Cox Ford, and 3 meters from center of road. Azimuth, 57° 40′; distance, 201 meters.

PERMANENT REFERENCE LINE COUNTY BRIDGE-DUKE'S PLACE.

P. R. P.—Pipe flange on left top bank of bayou in northeast corner of fence about cabin in field belonging to S. A. Duke, 15 meters north of cabin, 5 meters west of center of road, and 22 meters south of south end of county bridge across bayou, on a prolongation of the bridge. Elevation, 46.82.

P. A. P.—Nail in root of triangular-blazed 0.7-meter cow oak on right top bank of bayou, 11 meters northwest of north end of county bridge, 20 meters east of cabin on place of S. A. Duke, and 7 meters east of center of lane from end of bridge to main Baxter road. Azimuth, 181° 35′; distance, 177 meters.

PERMANENT REFERENCE LINE MOUNT CALVARY–RICHARDSON'S PLACE.

P. R. P.—Pipe flange in the southeast corner of fence about Mount Calvary Missionary Baptist Church (colored), 21 meters from right top bank of bayou, 7 meters west of center of road to Baxter. Elevation, 48.41.

P. A. P.—Nail in root of a triangular-blazed 0.4-meter red oak, 10 meters west of right top bank, 40 meters above downstream corner of field belonging to Nancy Richardson (colored). Azimuth, 299° 29′; distance, 231 meters.

PERMANENT REFERENCE LINE DUKE–LEPHIEW PLACE.

P. R. P.—Pipe-flange bench, in northeast corner of fence of field owned by S. A. Duke, 18 meters from right top bank, 7 meters from center of road, and 3 meters from center of lane dividing places of S. A. Duke and Henry Lephiew. Elevation, 49.63.

P. A. P.—Nail in root of triangular blazed 1.2-meter pecan on right top bank of bayou, 2 meters from center of road, 32 meters from cabin on Lephiew place. Azimuth, 252° 38′; distance, 429 meters.

PERMANENT REFERENCE LINE BAXTER–BAXTER.

P. R. P.—See descriptions, Parkeville, La., to Greenville, Miss., via Arkansas City, Ark. (p. 1487).

P. A. P.—Nail in root of triangular blazed 0.8-meter white oak, 60 meters from right top bank, 21 meters east of residence of Charles Duke, and 6 meters from center of north and south road. Azimuth, 187° 45′; distance, 98 meters.

SALINE RIVER.

PERMANENT REFERENCE LINE MARIE SALINE–MARIE SALINE LANDING.

See permanent reference lines along Ouachita River (p. 1524).

TABLE 2 E.—*Chain line.—Comparison of observed and carried azimuths.*

Locality.	Azimuth.						Discrepancy.		Number of intermediate stations.
	Observed.			Carried.					
Tensas River.	°	′	″	°	′	″	′	″	
Jonesville	166	52	39	166	53	39	1	00	187
Clayton	108	03	45	108	02	38	1	07	58
Mouth of Maçon	269	41	42	269	30	24	11	18	108
New Light	117	14	03	117	08	00	6	03	62
Mill Bayou	139	35	23	139	33	29	1	54	129
Indian Bayou	207	14	36	207	16	05	1	29	65
Alligator Bayou	157	49	12	157	50	57	1	45	128
Quebec	219	03	00	218	59	52	3	08	51
Dallas	188	05	23	Initial.			Initial.		....
Bayou Maçon.									
Mouth of Maçon	269	41	42	269	45	57	4	15	83
Cut-off Landing	163	17	37	163	22	33	4	56	87
Osbornes Landing	255	40	59	255	48	29	7	30	131
Sunrise Landing	266	23	14	266	30	35	7	11	135
Delhi	270	35	02	Initial.			Initial.		....
Floyd	202	04	18	202	03	15	1	03	156
Bœuf River.									
Stafford	*47	40	33	47	37	55	2	38	72
Dalys Landing	208	31	08	208	23	43	7	25	53
White Oak Landing	131	23	38	131	23	46	0	08	25

*Ouachita River chain-line azimuth not observed.

TABLE 2 E.—*Chain line.—Comparison of observed and carried azimuths*—Continued.

Locality.	Azimuth.						Discrepancy.		Number of intermediate stations.
	Observed.			Carried.					
	°	′	″	°	′	″	′	″	
Bœuf River—Continued.									
Three Rivers	215	43	19	215	43	08	0	11	26
Joes Bayou	240	26	45	240	28	50	2	05	18
Gum Point Landing	187	47	38	187	50	37	2	59	25
Mouth of Big Creek	145	19	00	145	18	29	0	31	30
Marengo Island	89	32	26	89	32	14	0	12	99
Irving Place	237	59	07	238	03	45	4	38	40
Girod Place	146	57	30	147	02	45	5	15	55
Mackintosh Place	136	02	41	136	09	38	6	57	46
Bacle Place	68	01	30	68	04	08	2	38	77
Boykin place	283	05	30	283	13	17	7	47	52
Girard	[a]184	14	08	Initial.			Initial.		....
White Island	176	55	26	176	52	20	3	06	47
Jordan place	204	37	00	204	38	40	1	40	63
Point Jefferson	170	22	40	170	20	50	1	50	63
Bayou Bartholomew.									
Ouachita City	[b]102	33	04	Initial.			Initial.		....
Meyers place	211	26	52	211	27	25	0	33	111
Jones Landing	98	27	44	98	27	38	0	06	27
Bonner Ferry	217	12	55	217	15	50	2	35	40
Ward place	246	51	59	246	51	21	0	38	36
Hope Landing	210	17	05	210	14	36	2	29	30
Rawlinsons Ferry	194	25	03	194	25	47	0	44	17
Knox Ferry	173	45	20	173	49	11	3	51	45
Shady Grove Church	285	03	33	284	57	15	6	18	53
State Line	202	42	19	202	47	48	5	29	60
Bells Ferry	176	05	01	175	58	57	6	04	46
Barnes place	178	34	43	178	34	00	0	43	48
Morris place	170	55	51	170	51	28	4	23	66
Anthonys place	227	07	12	227	08	30	1	18	20
Pughs place	183	53	35	183	57	04	3	29	39
Kitrells Landing	184	20	45	184	26	43	5	58	43
Noble place	218	47	54	218	49	09	1	15	29
Pruett Ferry	253	20	40	253	25	54	5	14	39
Whittington place	243	17	30	243	14	13	3	17	30
Cox Ford	173	23	41	173	19	17	4	24	53
County Bridge	188	13	20	188	15	22	2	02	48
Mount Calvary Church	164	14	56	164	13	49	1	07	25
Dukes place	250	27	47	250	25	11	2	36	41

[a] Mean of two observations.

[b] Ouachita River chain-line azimuth not observed.

TABLE 2 F.—*Chain line.—Azimuths and lengths of permanent reference lines along tributaries.*

TENSAS RIVER

[Tensas River enters Ouachita River 91.6 kilometers above mouth of Black River.]

Name of line.	Distance from mouth of Tensas River.	Azimuth.			Length.
	Kilometers.	°	′	″	*Meters.*
Gillespie-Jonesville	0.0	346	52	41	1,400.2
Stanton	9.4	124	56		410
Clayton	43.8	139	16	37	243
Tensas	52.5	329	17		....
Mouth of Maçon	68.7	269	41	42	878
Kings Camp	96.8	251	23		....
New Light	106.7	303	26		....
Dallas	221.8	95	43		322

TABLE 2 F.—*Chain line.—Azimuths and lengths of permanent reference lines along tributaries*—Continued.

BAYOU MAÇON.

[Bayou Maçon enters Tensas River 68.7 kilometers above its mouth.]

Name of line.	Distance from mouth of Bayou Maçon.	Azimuth.			Length.
	Kilometers.	°	′	″	*Meters.*
Mouth of Maçon	0.0	269	41	42	878
Cut-off	24.1	273	25	07	224
Osborne	57.2	255	40	59	304
Newcomer	100.1	266	23	14	269
Delhi	140.7	94	25	17	....
Epps, P. A. P. No. 1	164.3	123	37		....
Epps, P. A. P. No. 2	....	48	42		....
Floyd	179.5	161	45	44	....

BŒUF RIVER.

[Bœuf River enters Ouachita River 130.4 kilometers above the mouth of Black River.]

Name of line.	Distance from mouth of Boeuf River.	Azimuth.			Length.
	Kilometers.	°	′	″	*Meters.*
Stafford	0.0	47	40	33	432.5
Twin Rivers	9.0	90	48		1,018
DeSha	16.0	308	31		180
Daly	25.0	105	15		94
Long Reach	30.3	209	51		274
White Oak	44.2	232	20		210
Three Rivers	52.8	75	04		108
Joes Bayou	59.5	203	34		442
Gum Point	65.9	221	03		260
Omega-Wilderness (P. A. P.'s)	73.8	163	31		32
Omega-Wilderness (P. R. P. to P. A. P.)	73.6	206	54		139
Omega	73.6	217	49		117
Overflow	73.9	35	43		294
Muddy Bayou	77.0	182	48		173
Hebert-Lafourche (P. R. P.)	86.7	347	47		213
Duff	90.2	196	23		160
Wheeler	98.0	237	59	07	370
Harris	108.4	191	22		669
Elmore-Doucier (P. R. P.)	115.8	66	16		532
Noble "2"	124.2	298	17		169
Hatch	136.0	345	22		241
Stokes	148.9	49	43		301
Alto	162.3	272	54		279
Girard	195.7	275	12		664
White Island	213.5	355	23		520

BAYOU D'ARBONNE.

[Bayou D'Arbonne enters Ouachita River 304.2 kilometers above the mouth of Black River.]

Name of line.	Distance from mouth of Bayou D'Arbonne.	Azimuth.			Length.
	Kilometers.	°	′	″	*Meters.*
D'Arbonne-Pargoud	0.0	301	39	58	2,546

TABLE 2 F.—*Chain line.—Azimuths and lengths of permanent reference lines along tributaries*—Continued

BAYOU BARTHOLOMEW.

[Bayou Bartholomew enters Ouachita River 338.5 kilometers above the mouth of Black River.]

Name of line.	Distance from mouth of Bayou Bartholomew.	Azimuth.			Length.
	Kilometers.	°	'	"	*Meters.*
Ouachita-Parkeville	0.0	282	33	04	716
Sandidge	24.1	88	11		435
Meyers	32.4	64	11		300
Williams	42.3	30	19		174
Ross	46.1	199	30		220
Anderson	48.5	153	57		151
Bonner	55.7	103	47		133
Round Turns	57.4	215	28		711
Davis "2"	70.8	67	41		307
Ward	79.2	115	38		194
Wells	89.8	274	02		223
Mounds	105.9	15	00		209
Lindgrove	112.9	266	15		209
Shady Grove	120.6	148	46		154
Horseshoe	130.1	108	50		61
La-Ark	137.4	117	20		123
Noble "1"	165.8	31	37		201
Morris	186.3	344	25		140
McBride	215.4	158	48		417
Kitrell	222.6	12	17		158
Morrell	246.1	26	52		....
Cox	263.9	57	40		201
County Bridge	271.7	181	35		177
Mount Calvary	277.9	299	29		231
Duke	289.4	252	38		429
Baxter	292.6	187	45		98

SALINE RIVER.

[Saline River enters Ouachita River 409.8 kilometers above the mouth of Black River.]

Name of line.	Distance from mouth of Saline River.	Azimuth.			Length.
	Kilometers.	°	'	"	*Meters.*
Marie Saline[a]	([b])	100	48	00	494

[a] Not on river proper.

[b] About 4.3 kilometers down Ouachita River.

TABLE 3 A.—*High-water marks on Ouachita and Black rivers, Arkansas and Louisiana.*

Locality.	Kilometers above mouth of Black River.	Elevation in meters, Cairo datum.											
		1828.	1848.	1850.	1858.	1865.	1867.	1871.	1874.	1882.	1885.	1886.	1887.
Mouth of Black River	0.0									23.84			
Lum residence	25.0									24.36			
Whitaker place[a]	25.8 55.8									24.44			
West of Silver Lake[a]	53.4									24.68			
Flowery Mound place	56.5									24.65			
Below Magnolia place	57.9									24.63			
Magnolia place	58.0									24.62			
Oakland Landing	59.4									24.68			
Ganges Bayou	60.4									24.83			
Workinger Bayou	64.5									[b] 24.77			
Above Workinger Bayou[a]	65.5									21.79			
Tilden Place[a]	67.9									24.85			
Montgomery Store	70.9									24.85			
Wilson Place	73.9								24.11	24.89			
Normandy	78.5									[b] 24.94			
Security	79.5									24.90			
Zenor Place	81.3									25.07			
Herriman Place	88.7									25.16			
Jonesville	91.1									25.30			
Trinity	91.5						24.38	23.53	24.36	25.34			
Mouth of Tensas River	91.7							23.64					
Gillespie Place	93.9					24.67	24.68						
Mouth of Watson Lake	97.0							23.78					
Watson Place	105.5						24.94	23.97					
Harrisonburg	117.2	25.73		24.76	23.53	25.26	25.11			26.20			
Catahoula Shoals	123.1					25.48							
Zach Jones Place	127.8							24.60					
Stafford	130.3									26.54			
Below Danville	156.0							24.96					
Danville	156.7									27.39			
Oak Bluff	169.5						26.33	25.23					
Jones's wood yard	179.1							25.22					
Below Columbia	196.9					26.57	26.57						
Columbia	201.0									27.45			
Reddick Place	207.0							26.26					
St. Albans Point	216.6							26.57					
Sinope	224.6									27.67			
Waverly	227.7							27.00		27.54			
Logtown	259.5							28.06					
Brooks Place	276.9							28.38					

Monroe	294.7								30.47	30.80	30.46	24.83	25.90
Monroe	295.3								30.51				
Mouth of Bayou D'Arbonne	304.3					[b]27.85							
Above Bayou D'Arbonne	306.3						30.09						
Below Zeph Lake	311.2							29.01					
Mouth of Bayou Lonewa	320.4							29.61					
Rock Row	321.6						30.07						
Parkeville	338.7						30.49	[b]29.71					
Above Bayou Bartholomew	339.2							30.57					
Above Bayou Bartholomew	340.9							30.57					
Alabama Landing	360.6						30.88			32.33			
Mouth of Frank Pierre Creek	365.2					29.66			31.43				
Rolands Raft	386.7							30.70	33.02				
Below Bayou Lapile	394.7							30.79					
Marie Saline	405.6						31.39						
Below Garretts wood yard	435.9							31.03					
Above Pine Prairie Shoals	439.6							31.37					
Jacks Island	446.1							34.52					
Pigeon Hill	458.1									33.68			
Moro Bay	460.5								34.77	33.76			
Wilmington	468.7									34.97			
Champagnolle	490.5		35.35					37.68		35.82			
Eldorado	493.9						34.52	37.80					
Millers Bluff	513.4		35.81										
Below Newport	525.8						37.68						
Newport	526.6							40.14		38.15			
Beech Hill	527.4		38.26				37.80						
Frenchport	543.5		38.79										
Yaegers Towhead	553.0							40.25					
Bradleys Ferry	557.3						40.14						
Treadaway	562.5		40.84							41.72			
Camden	564.3		40.86				40.25			41.87		36.02	38.73
Arkadelphia	709.0		63.43							63.54 63.62			

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[a] Back from river.

[b] Uncertain.

TABLE 3 A.—*High-water marks on Ouachita and Black rivers, Arkansas and Louisiana*—Continued.

Locality.	Kilometers above mouth of Black River.	Elevation in meters, Cairo datum.												
		1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.
Mouth of Black River	0.0			23.41		23.32	22.86	20.30	16.79	18.90	23.53	19.52		
Delhoste Landing	0.1					23.35		20.32						
Acme	3.6					23.33	22.88							
Trislers	16.9					23.39		20.60						
New Era	19.6							20.61						
Lum's residence	25.0			23.63		23.65	23.07	20.64						
Whittaker's residence[a]	25.8 55.8			23.67			23.06							
West side of Silver Lake[a]	53.4			23.78			23.27							
Near Silver Lake[a]	55.5						23.24							
Flowery Mound Place	56.5			23.83			23.39							
Below Magnolia Place	57.9			23.82										
Below Ganges Bayou	59.9			23.81										
Ganges Bayou	60.4			23.87				21.33						
Burley and Hoyts Line	61.4			23.81										
Rabb Place	62.3			23.77		23.41								
Ferrell's Place	62.9			23.77										
Monterey	63.4			23.77										
Near Monterey	63.5						23.33							
Workinger Bayou	64.5			23.92										
Above Workinger Bayou	65.5			24 03										
Tilden Place	67.9			24.03										
Montgomerys Store	70.9			24.03			23.69							
Above Smith Landing	73.6			24.02		23.77								
Wilson Place	73.9			24.05										
Lismore	75.2			24.01										
Phillips Place	76.3			24.05		23.77								
Below Ross Bayou	76.8			24.14			23.84							
Normandy	78.5					23.81								
Above Normandy	78.9					[b]23.78								
Zenor Place	81.3			24.22										
Below Omega[b]	81.8						23.92							
Near Omega[b]	83.9			24.37			24.04							
Herriman Landing	88.5			24.31			24.14							
Herriman Place	88.7			24.33			24.18							
Black River Station	91.0			24.34			24.25	21.63	17.91	19.86	23.91	20.58	20.16	20.41
Jonesville	91.1			24.85		24.11	24.23							
Trinity	91.5						24.25							
Harrisonburg	117.2			25.08		24.88	25.01				23.95			
Above Harrisonburg	118.6			25.23										
Catahoula Shoals	121.6			25.33										

Stafford	130.8			25.91		25.58					24.26			
Cypress Slough	161.8					26.39	26.07							
Columbia	201.0					26.48	26.14							
Riverton	207.9					26.60	26.22	26.08	20.67	22.69	24.73	23.51	22.56	22.66
Ouachita-Caldwell Parish line	248.5					26.63								
Cuba	249.2							27.73						
Frank Place	250.3							27.88						
Logtown	259.5								22.30					
Noble Place	268.0							28.33						
Machoire a l'ours	269.3							28.36						
Monroe	294.7	26.08	26.02	28.83	27.39	28.18	27.86	29.32	23.56	25.68	27.15	26.54	25.45	25.05
Rock Row	322.4								24.18					
Ouachita City	338.2							30.79						
Bayou Bartholomew	338.5								24.59					
Alabama Landing	360.6										29.39			
Pigeon Hill	458.1								30.40					
Fletchers Landing	466.4							33.4						
Below Champagnolle	488.5							35.28						
Do	489.5							35.39						
Champagnolle	490.5					33.28		35.43	32.04	32.64	33.99	33.00	33.71	
El Dorado	493.9							35.53	32.29					
Newport	526.6										36.77			
Kelly's wood yard	528.5										36.90			
Frenchport	543.5								35.07					
Bradley Ferry	557.3										39.12			
Treadaway	562.5							41.05	36.39					
Camden	564.3	38.28	39.34	39.59	38.70	39.44	38.46	41.07	37.21	38.22	39.66	38.16	39.76	35.84
Arkadelphia	709.0					62.59								

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[a] Back from river.

[b] Uncertain.

TABLE 3 B.

High-water marks on Tensas River, Louisiana.

Locality.	Kilometers above mouth.	Elevation in meters, Cairo datum.							
		1844.	1850.	1858.	1882.	1890.	1893.	1894.	1897.
Chevy Chase Place	2.5						24.33		
Do	3.5				25.44				
Do	3.8						24.39		
Do	4.3				[a]25.48		24.51		
Do	6.7						24.63		
Athlone Place[b]	8.2						24.66		
Do.[b]	9.2						24.66		
Elkhorn Place[b]	12.6						24.74		
Do.[b]	13.1						24.75		
Churepa Place[b]	14.2						24.77		
Palmetto Place[b]	16.0				25.91		24.74		
Balenna Place[b]	16.7						24.74		
Do.[b]	16.8						24.74		
Do.[b]	17.1						24.76		
Moreland[b]	19.1						24.88		
Haphazard Place[b]	19.8						24.85		
Do.[b]	20.0	24.15	24.64	23.72	26.13		24.84		
Do.[b]	21.0						24.88		
Do.[b]	21.5						24.96		
Do.[b]	22.8				26.41	24.78			
Do.[b]	23.0						25.06		
Do.[b]	23.5						25.12		
Dunbarton Place[b]	28.6						25.19		24.57
Do.[b]	28.8				26.48				
Lamarque Place[b]	30.7						25.27		
Do.[b]	30.8								24.68
Do.[b]	31.0						25.28		
Do.[b]	31.1				26.54		25.28		
Do.[b]	32.4						25.29		
Do.[b]	33.2						25.35		
Do.[b]	33.5				26.56				
Do.[b]	33.7						25.38		
Do.[b]	34.2				26.70				
Rota Quinta Place[b]	36.2						25.86		
Do.[b]	36.8						25.41		
Do.[b]	36.9						25.41		
Do.[b]	37.4						25.42		
Moss Giel Place[b]	41.2				26.82				24.99
Do.[b]	42.0						25.56		
Do.[b]	43.0				26.83				
Do.[b]	43.1				26.88				
Clayton	43.9						25.62		25.17
Plassy Place[b]	44.5						25.65		
Do.[b]	44.8						25.67		25.16
Indian Village Place[b]	45.8						25.70		
Do.[b]	46.2				27.06				
Do.[b]	46.4						25.67		
Do.[b]	46.5				27.02				
Olympic Landing	48.7							22.0	25.28
O. K. Landing	50.4						25.64		25.29
Denmark Place	53.8						25.91		25.47
Kirks Ferry	61.4						[b]26.10		25.62
Mouth of Bayou Maçon	69.0				28.26				
Mound Bayou	105.1				29.78		28.19		
New Light Place	106.7						28.23		27.95
Bengal Place	119.6						28.60		28.41
Tensas Bluff	121.3						29.00		28.52
Indian Bayou	170.8				31.32		29.65		
Quebec Place	213.8						[b]31.42		
Do	214.2						31.53		
V., S. & P. Ry. bridge	221.8				[b]32.49		[b]30.47		

[a] Uncertain.

[b] Back from river.

High-water marks on Little Tensas River, Louisiana.

Locality.	Kilometers above mouth.	Elevation in meters, Cairo datum.		
		1882.	1890.	1893.
Indian Village Place	1.0	27.06		25.69
Winona Place	2.4			25.66
Do	2.5			25.66
Do	2.6			25.63
Tanglewood Place	3.5	27.39	25.42	25.70
Do	4.0			25.76

TABLE 3 B.—Continued.

High-water marks on Bayou Maçon, Louisiana.

Locality.	Kilometers above mouth.	Elevation in meters, Cairo datum.						
		1865.	1874.	1876.	1882.	1886.	1887.	1888.
Hopeka Place	2.4				28.12			
Lewis Place	24.9				28.41			
Anchor Ridge Landing	44.9				29.22			
Osborne Landing	57.3	28.49	28.11	27.56	29.59			
Delhi	140.7				33.09	31.17	31.02	28.37

Locality.	Kilometers above mouth.	Elevation in meters, Cairo datum.					
		1890.	1891.	1892.	1893.	1894.	1895.
Hopeka Place	2.3				26.52		
Cut-Off Landing	24.2				26.87		
Anchor Ridge Landing	44.9				27.54		
Osborne Landing	57.3	27.72			28.05		
Jose Bayou	126 6				31.68		
Do	128.4				31.26		
Delhi	140.7	31.32	29.80	30.93	31.87	27.69	24.95

High-water marks on Boeuf River, Louisiana.

Locality.	Kilometers above mouth.	Elevation in meters, Cairo datum.							
		1865.	1874.	1882.	1884.	1886.	1887.	1888.	1889.
Herbert Place	85.9			27.37					
Do	86.5		26.54	27.29					
Brandin Place	105.8			[a]27.53					
Do	106.2			27.57					
Landerneau	116.0			27.59	27.06				
Byargeon Place	129.1	26.82	27.53	27.58					
Sandiesca Place	133.0								
Hatch Place	136.0		26.82	27.41					
Washington Place	139.0			27.65					
Holden Place	145.0			27.61					
McElroy Place	148.0			27.61					
Charlieville	149.5			27.59					
Alto	162.5			28.36					
Girard	195.8					30.58	30.52	27.35	26.89
Jordan Ferry	224.0	32.25			32.41				
Mound Landing	239.1			33.70					

Locality.	Kilometers above mouth.	Elevation in meters, Cairo datum.						
		1890.	1891.	1892.	1893.	1894.	1895.	1897.
Herbert Place	86.5							24.38
Thomason Place	110.7						24.52	
Sandiesca Place	133.0							25.15
Hatch Place	136.0							25.18
Charlieville	149.5			27.16				25.84
Alto	162.5			28.27				
Girard	195.8	30.67	27.50	30.49	30.28	26.19		
Mound Landing	239.1			33.64				
Point Jefferson	242.7			34.57				

[a] Uncertain.

TABLE 3 B.—Continued.

High-water marks on Bayou D'Arbonne, Louisiana.

Locality.	Kilometers above mouth.	Elevation in meters, Cairo datum.		
		1867.	1874.	1883.
Whites Ferry	1.7	29.45		
	12.0			27.14
	19.0			27.41
	22.0			27.41
	24.0			27.41
	30.3			27.38
Ruggs Bluff	35.3			27.39
Joiner Ferry	44.4			27.39
Do	46.7			27.41
Cox Ferry	56.3		31.47	28.31

High-water marks on Bayou Cornie.

Locality.	Kilometers above mouth.	Elevation in meters, Cairo datum.		
		1874.	1882.	1883.
Scott Landing	3.3	31.74		
Near Steins Bluff	4.7	31.81		
Do	5.0		32.35	
Near Harris Bluff	10.6			30.15

High-water marks on Bayou Bartholomew, Louisiana and Arkansas.

Locality.	Kilometers above mouth.	Elevation in meters, Cairo datum.					
		1874.	1882.	1889.	1892.	1895.	1897.
Russell Place	2.9					30.50	
Little Bayou Boeuf	19.6		32.03				
Old Bonner Landing	65.9			[a]32.13			
Oak Landing	117.3						36.30
Huff Place	120.0	38.30					[a]37.13
Pedican Place	134.6						35.21
Noble Place	166.3	40.13					
Tebbs Ferry	201.1						41.18
Shearer Ferry	210.6					42.24	
Portland-Hamburg Ferry	215.6	43.42					
Holloway Place	217.9	[a]43.84					
Lloyd Place	222.2	43.88					
Morrell Ferry	246.1						[a]41.31
Baxter	292.6	48.16			46.98		

TABLE 3 C.—*Low-water marks on Ouachita and Black rivers, Arkansas and Louisiana.*

Locality.	Kilometers above mouth of Black River.	Elevation in meters, Cairo datum.						
		1871.	1873.	1875.	1876.	1879.	1880.	1881.
Trinity	91.5		8.70					
Columbia	201.0		12.41					
Waverly	227.7		12.80					
Monroe	294.7		16.00			15.79		-15.59
Caney Marie Landing	424.3	19.87	20.97					
El Dorado	494.0		24.21					
Buffalo Flats	530.6		26.91					
Camden	564.4		28.77	28.64	28.49		28.85	28.77

[a] Uncertain.

TABLE 3 C.—*Low-water marks on the Ouachita and Black rivers, Arkansas and Louisiana*—Continued.

Locality.	Kilometers above mouth of Black River.	Elevation in meters, Cairo datum.					
		1882.	1883.	1884.	1885.	1886.	1887.
Trinity	91.5						
Columbia	201.0						
Waverly	227.7						
Monroe	294.7		15.91	15.94	15.93	15.96	15.69
Caney Marie Landing	424.3						
El Dorado	494.0						
Buffalo Flats	530.6						
Camden	564.4	28.88			28.89	28.71	28.40

Locality.	Kilometers above mouth of Black River.	Elevation in meters, Cairo datum.						
		1888.	1889.	1890.	1891.	1892.	1893.	1894.
Mouth of Black River	0.0						8.01	7.35
Black River Station	91.0					9.98	8.73	8.37
Riverton	207.9					11.84	11.13	11.41
Monroe	294.7	15.90	15.93	16.32	15.93	16.17	15.99	15.95
Camden	564.4	28.55	28.55	28.92	28.73	28.92	28.68	28.71
Arkadelphia	709.0					56.32		

Locality.	Kilometers above mouth of Black River.	Elevation in meters, Cairo datum.					
		1895.	1896.	1897.	1898.	1899.	1900.
Mouth of Black River	0.0	7.71	7.54	6.90	9.54		
Beard Landing	41.4		7.71				
Black River Station	91.0	8.22	8.03	7.76	10.32	8.06	9.34
Above Harrisonburg	118.8		8.24				
Stafford	130.3		9.74				
Riverton	207.9	11.22	11.01	10.89	11.38	10.92	11.74
Logtown	258.8		11.18				
Monroe	294.7	15.89	15.72	15.66	15.99	15.66	15.85
Ouachita City	338.2	18.57					
Below Fishtrap Shoals	349.0	18.73					
Above Fishtrap Shoals	355.3	19.04					
Marie Saline Landing	405.6	20.21					
Jacks Island	446.1	22.35					
Champagnolle[a]	490.5	24.11	23.85	23.91	23.18		
Newport	526.6	25.82		25.61			
Camden	564.4	28.74	28.61	28.58	28.83	28.56	28.79

[a] Uncertain.

TABLE 3 D.—*Low-water marks on tributaries to Ouachita and Black rivers, Arkansas and Louisiana.*

Tributary.	Distance of tributary from mouth of Black River.	Locality.	Kilometers above mouth of tributary.	Elevation in meters, Cairo datum.						
				(?)	1883.	1886.	1887.	1888.	1889.	1890.
	Kilometers.									
Tensas River	91.6	Clayton	43.9	12.49						
Bayou Maçon	160.3	Delhi	140.7			21.36	21.48	21.81	21.51	21.75
Boeuf River	130.4	Girard	195.8			22.56	22.53	22.56	22.35	
Bayou d'Arbonne	304.2		30.3		19.85					
Do		Ruggs Bluff	36.6		20.58					
Do		Near mouth Bayou Cornie.	62.7		22.19					
Bayou Cornie	366.7	Scotts Bluff	3.3		22.92					

TABLE 3 D.—*Low-water marks on tributaries to Ouachita and Black rivers, Arkansas and Louisiana*—Continued.

Tributary.	Distance of tributary from mouth of Black River.	Locality.	Kilometers above mouth of tributary.	Elevation in meters, Cairo datum.						
				1891.	1892.	1893.	1894.	1897.	1898.	1899.
	Kilometers.									
Bayou Maçon....	160.3	Delhi	140.7	21.57	21.54	......	......	......	......	......
Bœuf River......	130.4	Mason Landing.	57.4	......	......	......	......	......	......	15.25
Do............		Heberts.......	86.5	......	......	......	......	......	......	16.43
Do............		Landerneau ..	116.0	......	......	......	......	......	......	17.82
Do............		Alto...........	162.5	......	......	......	......	......	......	20.11
Do............		Girard	195.8	22.44	22.56	22.44	22.32	......	22.29	22.08
Bayou Bartholomew.	338.5	Baxter........	292.6	......	......	......	......	40.98	41.02	40.99

TABLE 4 A.—*Freshets in Ouachita and Black rivers during low-water period.*

[Gauge at Camden. Graduations in feet and tenths. Zero, 91.37 feet C. D.]

Year.	Low water.		Number of days above certain gauge readings.									Number of rises above certain gauge readings.								
	Begins.	Ends.	6	8	10	11	13	15	16	18	20	6	8	10	11	13	15	16	18	20
1873........	June 29	Nov. 24	24	16	9	8	6	4	4	3	2	4	4	2	2	2	1	1	1	1
1875........	Apr. 23	Dec. 25	45	35	30	27	24	22	19	18	13	4	3	3	3	3	3	2	2	2
1880........	May 11	Oct. 26	36	26	16	13	13	8	6	1	0	4	2	2	2	2	2	1	....	....
1881........	June 7	Dec. 15	15	11	7	6	6	6	4	4	3	2	1	1	1	1	1	1	1	1
1882........	June 11	Nov. 9	18	8	5	4	3	2	2	1	....	3	3	2	1	1	1	1	1	....
1886........	May 1	Nov. 13	35	22	12	3	3	2	1	....	....	6	7	5	1	1	1	1	....	....
1888........	May 10	Dec. 16	57	45	37	22	18	12	9	8	8	5	7	5	4	4	3	2	1	1
1889........	May 12	Nov. 9	33	22	18	15	10	6	5	3	3	5	4	4	2	2	1	1	1	1
1890........	June 27	Nov. 12	13	11	10	9	7	6	4	1	1	1	1	1	1	1	1	1	1	1
1891........	May 10	Dec. 23	44	30	25	18	16	13	11	11	9	8	4	3	3	1	1	1	1	1
1892........	June 23	Nov. 1	32	9	5	1	....	....	....	....	....	6	4	3	1	....	....	....	....	....
1893........	July 7	1894. Jan. 22	6	2	....	....	....	....	....	....	....	1	1	1	....	....	....	....	....	....
1894........	May 19	1895. Jan. 21	9	6	2	....	....	....	....	....	....	2	2	2	....	....	....	....	....	....
1895........	May 16	Nov. 27	57	41	31	23	19	15	9	8	4	6	6	5	5	4	4	3	3	2
1896........	Apr. 25	1897. Jan. 3	17	11	8	3	1	....	....	....	....	4	2	2	2	1	....	....	....	....
1897........	Apr. 26	Dec. 22	9	6	3	2	....	....	....	....	....	2	2	1	1	....	....	....	....	....
1898........	May 30	1899. Jan. 7	31	11	4	....	....	....	....	....	....	5	5	3	1	....	....	....	....	....
1899........	June 23	1900. Jan. 13	23	8	4	....	....	....	....	....	....	3	2	2	....	....	....	....	....	....
1900........	July 5	Nov. 22	70	34	16	13	10	4	....	....	....	5	5	4	4	3	2	....	....	....
1901........	May 29	1901. Dec. 10	21	6	4	3	2	....	....	....	....	3	2	2	1	1	....	....	....	....
Average.	May 28	Dec. 9	29.8	18.0	12.4	8.5	6.9	5.0	3.7	2.9	2.1	4.0	3.3	2.6	1.8	1.3	1.0	0.8	0.6	0.5

TABLE 4 A.—*Freshets in Ouachita and Black rivers in low-water period*—Continued.

[Gauge at Monroe. Graduations in feet and tenths. Zero, 51.38 feet C. D.]

Year.	Low water.		Number of days above certain gauge readings.									Number of rises above certain gauge readings.								
	Begins.	Ends.	3	5	6	8	10	11	13	15	18	3	5	6	8	10	11	13	15	18
1890	Aug. 2	Nov. 16	86	59	54	19	16	13	....	....	....	2	1	1	1	1	1	...	...	...
1891	Sept. 6	Dec. 25	40	15	....	....	....	....	....	....	....	1	1	...	...	...	...	...	...	...
1892	Aug. 24	Nov. 5	50	40	25	17	10	....	....	....	....	1	1	2	2	2	...	...	...	...
1893	Aug. 12	1894. Jan. 9	63	47	21	....	....	....	....	....	....	1	2	3	...	...	...	...	...	...
1894	June 28	1895. Jan. 24	86	26	13	....	....	....	....	....	....	5	3	2	...	...	...	...	...	...
1895	Aug. 19	Dec. 25	38	22	14	7	....	....	....	....	....	1	2	2	1	...	...	...	...	...
1896	May 27	1897. Jan. 5	47	23	14	12	12	10	8	4	....	2	1	1	1	1	1	1	1	...
1897	July 1	Dec. 22	8	2	1	....	....	....	....	....	....	2	1	1	...	...	...	...	...	...
1898	July 7	1898. Nov. 10	81	54	23	11	8	7	1	....	....	2	2	2	1	1	1	1	...	...
1899	July 1	1900. Jan. 18	43	12	2	1	....	....	....	....	....	4	2	1	...	...	...	...	...	...
1900	July 20	Nov. 27	69	46	10	7	....	....	....	....	....	4	5	2	1	...	...	...	...	...
1901	June 4	1901. Dec. 15	51	22	13	2	....	....	....	....	....	4	2	2	1	...	...	...	...	...
Average	July 18	Dec. 17	55.2	30.7	15.8	6.3	3.9	2.5	0.8	0.3	....	2.4	1.9	1.6	0.7	0.4	0.2	0.1	0.1	...

[Gauge at Riverton. Graduations in feet and tenths. Zero, 35.20 feet C. D.]

Year.	Low water.		Number of days above certain gauge readings.									Number of rises above certain gauge readings.								
	Begins.	Ends.	3	5	6	8	10	11	13	15	18	3	5	6	8	10	11	13	15	18
1893	Aug. 25	Dec. 21	39	30	14	8	6	....	....	....	....	1	1	1	1	1	...	...	...	...
1894	July 17	1895. Jan. 15	107	72	21	3	....	....	....	....	....	3	4	1	1	...	...	...	...	...
1895	Aug. 29	Dec. 25	41	31	26	13	4	4	....	....	....	1	1	1	1	1	1	...	...	...
1896	June 29	1896. Nov. 29	65	36	26	19	15	....	....	....	....	3	2	1	1	1	...	...	...	...
1897	July 20	Dec. 20	37	26	7	....	....	....	....	....	....	3	2	1	...	...	...	...	...	...
1898	Aug. 5	Oct. 1	42	34	26	7	....	....	....	....	....	1	1	2	1	...	...	...	...	...
1899	July 13	1900. Jan. 23	79	60	53	35	....	....	....	....	....	1	1	2	2	...	...	...	...	...
1900	Aug. 21	Dec. 2	90	57	45	26	10	....	....	....	....	2	3	4	4	2	...	...	...	...
1901	June 29	Dec. 15	86	43	32	14	1	....	....	....	....	5	4	3	3	1	...	...	...	...
Average	July 28	Dec. 13	65.1	43.2	27.8	15.0	4.0	0.4	....	....	....	2.2	2.1	1.8	1.6	0.7	0.1	...	...	...

[Gauge at Black River Station. Graduations in feet and tenths. Zero, 24.77 feet C. D.]

Year.	Low water.		Number of days above certain gauge readings.									Number of rises above certain gauge readings.								
	Begins.	Ends.	5	6	8	10	11	13	15	16	18	5	6	8	10	11	13	15	16	18
1893	Sept. 10	Dec. 6	54	22	10	....	....	....	....	....	....	2	2	1	...	...	...	...	...	...
1894	July 29	(a)	102	71	26	....	....	....	....	....	....	1	3	3	...	...	...	...	...	...
1895	Sept. 9	Dec. 26	52	44	24	9	....	....	....	....	....	1	1	2	1	...	...	...	...	...
1896	Sept. 1	Nov. 30	41	10	5	....	....	....	....	....	....	1	2	1	...	...	...	...	...	...
1897	Aug. 27	Dec. 3	10	5	2	....	....	....	....	....	....	1	1	1	...	...	...	...	...	...
1898	Sept. 11	Sept.(b)	....	....	....	....	....	....	....	....	....	...	...	...	...	...	...	...	...	...
1899	Aug. 31	Dec. 1	12	9	5	....	....	....	....	....	....	1	1	1	...	...	...	...	...	...
1900	Aug. 25	Nov. 6	73	65	45	6	....	....	....	....	....	1	1	3	1	...	...	...	...	...
1901	July 31	Dec. 16	107	92	47	24	14	8	....	....	....	1	2	2	2	1	1	...	...	...
Average	Aug. 26	Nov. 30	50.1	35.5	18.2	4.3	1.6	0.9	....	....	....	1.0	1.5	1.6	0.4	0.1	0.1	...	...	...

[a] **January 15, 1895.**

[b] **No record from September 14 to 22,** during which time the river rose above 10-foot mark.

TABLE 4 A.—*Freshets in Ouachita and Black rivers during low-water period*—Continued.

[Gauge at mouth of Black River. Graduations in meters. Zero, —0.23 feet C. D.]

Year.	Low water.		Number of days above certain gauge readings expressed in feet.									Number of rises above certain gauge readings expressed in feet.								
	Begins.	Ends.	28	29	31	33	35	37	38	40	42	28	29	31	33	35	37	38	40	42
1895	Sept. 13	Dec. 28	54	35	18	....	....	....	....	....	....	1	2	1	...	...	...	...	...	...
1896	Sept. 5	Nov. 30	41	13	4	....	....	....	....	....	....	1	1	1	...	...	...	...	...	...
1897	Sept. 5	Dec. 4	25	14	6	....	....	....	....	....	....	1	...	...	...	...	...	...	...	...
1898	....	(a)	....	....	....	....	....	....	....	....	....	...	...	...	...	...	...	...	...	...
Average	Sept. 8	Dec. 11	40.0	20.7	9.3	....	....	....	....	....	....	1.0	1.0	0.7	...	...	...	...	...	...

[a] Gauge above the low-water stage throughout the entire year.

TABLE 4 B.—*Low stages in Ouachita and Black rivers during high-water period.*

[Gauge at Camden, Ark. Highest water (1882), 56.0 feet on gauge. Lowest water (1887), 1.8 feet on gauge.]

Year.	High-water period.		Below 10-foot mark.	
	Begins.	Ends.	Days.	Times.
1890	Nov. 13	May 10, 1891	13	1
1891	Dec. 24	June 22, 1892	15	2
1892	Nov. 2	July 2, 1893	18	4
1894	Jan. 22	May 18, ——	9	2
1895	Jan. 21	May 15, ——	25	1
1895a	Nov. 28	Apr. 24, 1896	31	5
1897	Jan. 2	Apr. 25, ——	26	2
1897a	Dec. 23	May 29, 1898	57	6
1899	Jan. 2	June 22, ——	33	4
1900	Jan. 14	July 5, ——	62	7
1900a	Nov. 23	May 23, 1901	73	6
1901	Dec. 10	Incomplete.	4	1
Average	Dec. 10	May 27	32.9	3.6

[Gauge at Monroe, La. Highest water (1882), 48.7 feet on gauge. Lowest water, below zero of gauge.]

Year.	High-water period.		Below 8-foot mark.	
	Begins.	Ends.	Days.	Times.
1890	Nov. 17	Sept. 5, 1891	56	1
1891	Dec. 26	Aug. 23, 1892	0	0
1892	Nov. 6	Aug. 11, 1893	0	0
1894	Jan. 10	June 27, ——	0	0
1895	Jan. 25	Aug. 18, ——	20	2
1895a	Dec. 26	May 26, 1896	0	0
1897	Jan. 6	June 30, ——	0	0
1897a	Dec. 23	July 6, 1898	0	0
1898	Nov. 11	June 30, 1899	0	0
1900	Jan. 19	July 19, ——	13	2
1900a	Nov. 28	June 3, 1891	8	1
1901	Dec. 16	Incomplete.	0	0
Average	Dec. 18	July 17	8.9	0.5

TABLE 4 B.—*Low stages in Ouachita and Black rivers during high water period*—Continued.

[Gauge at Riverton, La. Highest water (1882), 55.4 feet on gauge. Lowest water (1897), 0.5 foot on gauge.]

Year.	High-water period.		Below 9-foot mark.	
	Begins.	Ends.	Days.	Times.
1893	Dec. 22	July 16, 1894	4	1
1895	Jan. 15	Aug. 28, ——	5	1
1895a	Dec. 26	June 28, 1896	0	0
1896	Nov. 30	July 19, 1897	13	1
1897	Dec. 21	Aug. 4, 1898	0	0
1898	Oct. 2	July 12, 1899	0	0
1900	Jan. 24	Aug. 20, ——	0	0
1900a	Dec. 3	June 28, 1901	0	0
1901	Dec. 16	Incomplete.	0	0
Average	Dec. 14	July 27	2.8	0.4

[Gauge at Black River Station, La. Highest water (1882), 58.4 feet on gauge. Lowest water (1897), 0.7 foot on gauge.]

Year.	High-water period.		Below 10-foot mark.	
	Begins.	Ends.	Days.	Times.
1893	Dec. 7	July 28, 1894	0	0
1895	Jan. 16	Sept. 8, ——	0	0
1895a	Dec. 27	Aug. 31, 1896	0	0
1896	Nov. 30	Aug. 26, 1897	0	0
1897	Dec. 4	Sept. 10, 1898	3	1
1898	Sept. 19	Aug. 30, 1899	0	0
1899	Dec. 2	Aug. 24, 1900	3	1
1900	Nov. 6	July 31, 1901	1	1
1901	Dec. 17	Incomplete.	0	0
Average	Dec. 1	Aug. 25	0.9	0.4

[Gauge at mouth of Black River, Louisiana. Highest water (1882), 78.4 feet on gauge. Lowest water (1897), 22.9 feet on gauge.]

Year.	High-water period.		Below 33-foot mark.	
	Begins—	Ends—	Days.	Times.
1895	Dec. 28	Sept. 5, 1896	River never less than 10 feet above "low water" during "high-water period."	
1896	Nov. 31	Sept. 4, 1897		
1897	Dec. 5	Dec. 31, ——		
1898	Jan. 1	Dec. 31, ——		

TABLE 5 A.—*Slope observations on Bœuf River, Louisiana.*

Locality.	Kilometers above mouth.	Elevation in meters, Cairo datum.
	72.8	[a]24.3
Mouth of Big Creek	73.9	24.3
Mouth of Muddy Bayou	76.9	24.3
Above Muddy Bayou	77.9	24.3
	80.0	24.3
	80.8	24.3
Mouth of Daves Bayou	82.8	24.4
Duff Place	90.1	24.4
Wheeler Place	98.0	24.3
Do	99.0	24.5
Below Bœuf River post-office	100.1	24.6
	103.5	24.5
Brandin Place	104.0	24.5
Girod Place	106.8	24.4
Do	110.0	24.5
Thomason Place	110.7	[b]24.5

[a] Mud stains, supposed to be high-water marks of 1895. [b] Authentic high-water mark of 1895.

TABLE 5 A.—*Slope observations on Bœuf River, Louisiana*—Continued.

Locality.	Kilometers above mouth.	Elevation in meters, Cairo datum.
Elmore and King place	113.0	24.5
Landerneau	116.0	24.6
Richland-Caldwell Parish line	116.4	24.7
Fletcher Place	118.4	24.9
Do	119.0	24.6
Do	119.5	24.8
Elmore and King place	120.2	24.7
Do	121.0	24.6
Independence Place	121.8	25.2
Do	122.6	24.7
Do	123.0	24.7
Thomason Landing	123.8	24.7
Dr. Noble's place	124.0	24.1
Below Copeland Landing	126.2	24.9
Copeland Landing	127.7	24.6
Myer Place	128.4	24.8
Byargeon Place	129.1	25.0
Richland Ferry	136.0	26.8
McElroy Place	148.0	26.9
Walnut Bluff Landing	151.0	27.7

TABLE 5 B.—*Slope observations of Bayou Bartholomew, Louisiana.*

[Ice marks of February, 1899.]

Locality.	Kilometers above mouth.	Elevation in meters, Cairo datum.
Bussey Place	70.1	30.3
Ward Place	74.5	30.4
Pratt Place	78.2	30.8
Hope Place	80.5	31.2
Mason Place	82.9	31.1
Level Place	85.0	31.3
Vesta Ferry	91.6	31.7
	93.3	31.7
Morris and Herrall Place	94.4	31.8
Do	95.9	31.9
Do	97.8	32.1
Do	100.5	32.3
Do	100.8	32.4
	102.8	32.4
Johnson Place	103.7	32.5
Level Place	107.9	32.8
Do	108.7	32.7
Nunn Place	108.9	32.8
Do	109.3	32.7
Do	110.2	32.8
Watt Place	111.8	32.9
Huff Place	119.7	33.4

TABLE 6.—*Permanent gauges.*

[Gauges on Ouachita and Black rivers, Arkansas and Louisiana.]

Locality.	Kilometers above mouth of Black River.	Authority.	Date established.	Graduation.	Elevation of zero (meters), Cairo datum.
Mouth of Black River	0.0	U. S. Engineers	1891	Meters	−0.07
Black River Station	91.0	do	1892	Feet	7.55
Stafford	130.3	do	1896	Meters	0.00
Riverton	207.9	do	1892	Feet	10.73
Monroe[a]	294.7	U. S. Weather Bureau	1890	do	15.66
Ouachita City	338.2	U. S. Engineers	1899	Meters	0.00
Champagnolle	490.5	do	1895	do	0.70
Camden	564.4	do	1890	Feet	27.85
Arkadelphia	709.0	do	1892	do	55.90

[a] Gauge built on bridge pier of varying batter.

Table 6.—*Permanent gauges*—Continued.

[Gauges on Tensas River, Louisiana.]

Locality.	Kilometers above mouth.	Authority.	Date established.	Graduation.	Elevation of zero (meters), Cairo datum.
Clayton	43.8	U. S. Engineers	1898	Meters	0.98
Kirks Ferry	61.2	do	1898	do	0.98
Mound Bayou	105.1	do	1898	Feet	13.14
Jacks Bayou	169.9	do	1898	do	19.23
Dallas	221.8	do	1898	do	22.67

[Gauges on Bayou Maçon, Louisiana.]

Locality.	Kilometers above mouth.	Authority.	Date established.	Graduation.	Elevation of zero (meters), Cairo datum.
Above Cut-off Bayou	25.1	U. S. Engineers	1898	Meters	− 0.10
Delhi	140.7	U. S. Weather Bureau	1885	Feet	21.61

[Gauges on Bœuf River, Louisiana.]

Locality.	Kilometers above mouth.	Authority.	Date established.	Graduation.	Elevation of zero (meters), Cairo datum.
Masons Landing	57.3	U. S. Engineers	1899	Meters.	− 0.05
Heberts	86.5	do	1898	Meters.	0.05
Landerneau	116.0	do	1898	Meters.	− 0.05
Alto	162.5	do	1898	Meters.	0.00
Girard	195.7	U. S. Weather Bureau	1886	Feet.	22.30
Point Jefferson	242.7	U. S. Engineers	1898	Meters.	− 0.02

[Gauges on Bayou Bartholomew, Louisiana and Arkansas.]

Locality.	Kilometers above mouth.	Authority.	Date established	Graduation.	Elevation of zero (meters), Cairo datum.
Sandidge Place	26.7	U. S. Engineers	1897	Meters.	22.53
Pratt Place	77.2	do	1897	Meters.	26.98
Lindgrove	113.1	do	1897	Meters.	29.04
Parkdale	172.6	do	1897	Meters.	32.27
Morrell	245.8	do	1897	Meters.	36.43
Baxter	292.6	do	1897	Meters.	40.61

Table 7 A.—*Discharge observations in Ouachita and Black rivers, Arkansas and Louisiana.*

Locality.	Above mouth of Black River.	Date.	Area.	Maximum mid-depth velocities.	Discharge.	Elevation of water surface above Cairo datum.	Stage above low water of 1896.
	Kilometers.	1891.	*Sq. meters.*	*Meters per second.*	*Cu. meters.*	*Meters.*	*Meters.*
Near mouth of Black River	0.6	July 18	1,461	0.41	529	15.08	7.54
Do	0.6	July 20	1,410	0.42	540	14.68	7.14
Do	0.6	July 21	1,376	0.47	524	14.48	6.94
Do	0.6	July 22	1,342	0.48	516	14.30	6.66
Do	0.6	July 23	1,309	0.44	478	14.10	6.56
Do	0.6	July 24	1,275	0.47	465	13.91	6.37
Do	0.6	July 25	1,242	0.42	446	13.74	6.20
Do	0.6	July 26	1,226	0.44	412	13.59	6.05
Do	0.6	July 27	1,209	0.44	412	13.45	5.91
Do	0.6	Dec. 21	771	0.35	222	10.59	3.05

TABLE 7 A.—*Discharge observations in Ouachita and Black rivers, Arkansas and Louisiana*—Continued.

Localty.	Above mouth of Black River.	Date.	Area.	Maximum mid-depth velocities.	Discharge.	Elevation of water surface above Cairo datum.	Stage above low water of 1896.
	Kilometers.	1893.	*Sq. meters.*	*Meters per second.*	*Cu. meters.*	*Meters.*	*Meters.*
Near mouth of Black River	0.6	Mar. 14	2,279	0.55	1,128	19.06	11.52
Do	0.6	Oct. 30	438	0.29	98	8.50	1.00
		1896.					
Do	0.6	Dec. 22	958	0.39	329	11.52	3.98
Lanius	6.0	Dec. 19	942	0.40	344	12.22	4.65
Below Beards	40.2	Dec. 9	1,005	0.59	510	12.43	4.72
		1900.					
Newhope	63.4	Mar. 28	2,170	0.63	1,069	18.48	10.58
Do	63.4	Mar. 27	2,188	0.66	1,123	18.54	10.64
		1894.					
Jonesville	91.4	Nov. 20	396	0.23	67	8.58	0.58
Do	91.4	Nov. 21	395	0.21	66	8.53	0.53
Do	91.4	Nov. 23	395	0.20	68	8.50	0.50
Do	91.4	Nov. 24	395	0.22	73	8.51	0.51
Do	91.4	Nov. 26	395	0.22	68	8.47	0.47
Do	91.4	Nov. 27	396	0.20	64	8.45	0.45
Trinity	92.1	Nov. 20	915	0.06	36	8.55	0.56
Do	92.1	Nov. 21	911	0.08	38	8.52	0.53
Do	92.1	Nov. 22	910	0.10	67	8.51	0.52
Do	92.1	Nov. 24	910	0.12	70	8.51	0.52
Do	92.1	Nov. 26	903	0.15	75	8.45	0.46
Do	92.1	Nov. 27	901	0.13	54	8.44	0.45
		1896.					
Harrisonburg	117.7	Oct. 30	110	0.48	47	8.90	0.67
Do	117.7	Nov. 11	156	0.64	84	9.40	1.17
Catahoula Shoals	124.6	Oct. 23	43	1.05	31	9.80	0.31
		1890.					
Do	124.4	Aug. 22	168	[a]0.89	111	11.24	1.75
Do	123.7	Aug. 23	138	[a]0.75	109	11.09	1.60
		1894.					
Do	123.7	Dec. 5	50	1.02	32	9.82	0.46
Do	123.7	Dec. 6	51	1.00	35	9.83	0.47
Do	123.7	Dec. 7	51	1.05	37	9.84	0.48
Do	123.7	Dec. 8	51	1.13	39	9.84	0.48
Do	123.7	Dec. 10	60	1.17	53	10.10	0.74
Do	123.7	Dec. 11	63	1.38	65	10.19	0.83
Do	123.7	Dec. 12	66	1.33	68	10.30	0.94
Do	123.7	Dec. 13	72	1.41	74	10.31	0.95
Do	123.7	Dec. 14	71	1.41	85	10.37	1.01
Do	123.7	Dec. 15	73	1.69	107	10.44	1.08
Do	123.7	Dec. 17	79	1.95	141	10.61	1.25
Do	123.7	Dec. 18	84	2.09	181	10.77	1.41
Do	123.7	Dec. 19	89	2.04	197	10.90	1.54
Do	123.7	Dec. 20	91	2.09	203	10.95	1.59
		1900.					
Do	123.7	Mar. 23	1,618	0.68	930	18.39	9.03
Do	123.7	Mar. 24	1,632	0.71	991	18.54	9.18
		1896.					
Cottingham	158.9	Oct. 15	58	0.53	29	10.13	0.15
Wade Place	189.9	Oct. 7	43	0.44	16	10.26	0.04
		1895.					
Columbia	201.0	Dec. 28	495	0.87	325	15.15	4.67
		1896.					
Do	201.0	Oct. 1	33	0.48	14	10.52	0.04
		1900.					
Above Columbia	205.0	Mar. 20	1,349	0.79	868	19.65	8.65
Do	205.0	Mar. 21	1,335	0.80	845	19.71	8.71
Hopewell Place	231.8	Mar. 14	1,116	0.91	734	19.70	7.40
Do	231.8	Mar. 15	1,149	0.85	717	19.81	7.51
Watkins Place	256.0	Mar. 9	835	0.90	615	20.87	6.80
Do	256.0	Mar. 10	905	0.92	976	21.02	6.95
		1895.					
Logtown	260.1	Dec. 11	297	0.66	162	16.42	2.23
Above Toncy Bayou	289.8	Dec. 3	480	0.82	288	18.36	2.81

[a] Observations made with surface floats and reduced to mid-depth velocity.

TABLE 7 A.—*Discharge observations in Ouachita and Black rivers, Arkansas and Louisiana*—Continued.

Locality.	Above mouth of Black River.	Date.	Area.	Maximum mid-depth velocities.	Discharge.	Elevation of water surface above Cairo datum.	Stage above low water of 1896.
	Kilometers.	1897.	*Sq. meters.*	*Meters per second.*	*Cu. meters.*	*Meters.*	*Meters.*
Monroe	294.3	Mar. 28	2,026	0.89	1,519	26.05	10.29
Do	294.3	Mar. 29	2,059	0.93	1,592	26.26	10.50
Do	294.3	Mar. 30	2,085	0.94	1,674	26.39	10.63
Do	294.3	Mar. 31	2,102	0.94	1,630	26.56	10.80
Do	294.3	Apr. 1	2,113	0.88	1,601	26.70	10.94
Do	294.3	Apr. 2	2,170	0.87	1,649	26.83	11.07
Do	294.3	Apr. 3	2,183	0.93	1,662	26.91	11.15
Do	294.3	Apr. 5	2,199	0.91	1,646	27.06	11.30
Do	294.3	Apr. 6	2,190	0.91	1,557	27.10	11.34
Do	294.3	Apr. 8	2,228	0.84	1,541	27.14	11.38
Do	294.3	Apr. 9	2,177	0.86	1,610	27.17	11.41
Do	294.3	Apr. 10	2,152	0.91	1,550	27.17	11.41
Do	294.3	Apr. 13	2,122	0.88	1,501	27.13	11.37
Monroe	294.3	Apr. 15	2,144	0.82	1,497	27.06	11.30
Do	294.3	Apr. 17	2,110	0.82	1,443	26.97	11.21
Do	294.3	Apr. 19	2,095	0.83	1,390	26.89	11.13
Do	294.3	Apr. 21	2,078	0.80	1,422	26.81	11.05
Do	294.3	Apr. 23	2,076	0.80	1,352	26.75	10.99
Do	294.3	Apr. 26	2,064	0.74	1,171	26.65	10.89
Do	294.3	Apr. 27	2,022	0.74	1,220	26.60	10.84
Do	294.6	Sept. 9	51	0.35	15	15.78	0.06
Do	294.6	Sept. 10	50	0.39	16	15.77	0.05
Do	294.6	Sept. 11	50	0.35	15	15.76	0.04
		1900.					
Do	294.6	Mar. 5	828	0.77	537	20.45	4.73
Do	294.6	Mar. 6	854	0.73	513	20.58	4.86
Henry Cooper Place	315.0	Feb. 24	329	0.66	176	19.14	1.94
Do	315.0	Feb. 25	354	0.70	200	19.28	2.08
		1895.					
Below Rock Row Shoals	322.2	Nov. 18	36	0.79	24	17.70	0.36
Rock Row Shoals (right channel)	322.5	Nov. 16	18	0.83	9	17.74	0.29
Rock Row Shoals (left channel)	322.5	Nov. 16	9	1.20	10	17.95	0.29
Above Rock Row Shoals	324.0	Nov. 16	119	0.22	17	18.06	0.29
		1900.					
Rock Row Shoals	320.0	Jan. 9	323	0.32	59	18.07	0.77
Do	320.0	Jan. 10	344	0.34	70	18.08	0.78
Rock Row Shoals	320.0	Feb. 17	584	0.70	323	20.38	3.08
Do	320.0	Feb. 19	533	0.66	278	19.98	2.68
		1895.					
Ouachita City	337.9	Nov. 14	57	0.41	18	18.60	0.26
		1900.					
Fish-trap Shoals	355.0	Feb. 10	341	0.63	108	20.02	1.27
Do	355.0	Feb. 13	508	0.91	296	21.53	2.78
		1895.					
Alabama Landing	360.6	Nov. 2	89	0.30	12	19.14	0.21
Mallard Shoals	372.6	Oct. 26	16	0.89	12	19.44	0.21
		1900.					
Marie Saline	405.8	Jan. 12	159	0.46	62	21.42	1.30
Do	405.8	Jan. 13	173	0.48	71	21.51	1.39
Ouachita Belle Landing.	414.7	Feb. 6	111	0.63	56	22.20	1.80
Do	414.7	Feb. 7	107	0.64	55	22.15	1.75
		1895.					
Eutaw Rapids	430.7	Oct. 11	38	0.43	10	21.19	0.29
		1900.					
Jacks Island	445.4	Jan. 16	409	1.04	317	26.09	3.91
Do	445.4	Jan. 17	430	0.92	286	26.06	3.89
Do	445.4	Feb. 2	131	0.67	75	23.66	1.48
Do	445.4	Feb. 3	119	0.61	64	23.53	1.35
		1895.					
Romeo Shoals	455.4	Oct. 2	29	0.65	12	23.33	0.41
Above Wilmington	470.0	Sept. 25	58	0.31	15	23.56	0.51

TABLE 7 A.—*Discharge observations in Ouachita and Black rivers, Arkansas and Louisiana*—Continued.

Locality.	Above mouth of Black River.	Date.	Area.	Maximum mid-depth velocities.	Discharge.	Elevation of water surface above Cairo datum	Stage above low water of 1836.
	Kilometers.	1900.	*Sq. meters.*	*Meters per second.*	*Cu. meters.*	*Meters.*	*Meters.*
Franklin Shoals	477.8	Jan. 30	217	0.54	91	25.29	2.09
Do	477.8	Jan. 31	201	0.56	91	25.03	1.83
		1873.					
Eldorado Shoals	494.6	Sept. 10	48	[a]0.43	17	24.31	0.43
		1897.					
Do	494.6	June 29	33	0.59	17	24.52	0.56
		1900.					
Smackover Shoals	501.0	Jan. 19	327	0.73	189	27.93	3.77
Do	501.0	Jan. 20	422	0.96	329	28.78	4.62
Do	501.0	Jan. 25	398	0.67	212	28.53	4.37
Do	501.0	Jan. 26	342	0.62	167	27.99	3.83
		1897.					
Haidee Shoals	506.6	June 25	62	0.39	22	25.61	0.73
Newport Shoals (right channel)	526.3	June 19	8	0.63	4	26.41	0.88
Newport Shoals (left channel)	526.3	June 19	29	0.88	22	26.34	0.87
		1900.					
Beech Hill	527.0	Jan. 22	565	1.00	449	31.30	5.76
Do	527.0	Jan. 23	493	0.78	322	30.73	5.19
Do	527.0	Jan. 24	382	0.72	230	29.91	4.37
Do	527.0	Jan. 25	343	0.64	185	29.27	3.73
Buffalo Flats	527.8	Aug. 1	119	0.74	70	27.24	1.66
Do	527.8	Aug. 2	150	0.77	90	27.50	1.92
Do	527.8	Aug. 3	164	0.81	123	27.82	2.24
Do	527.8	Aug. 3	164	0.81	122	27.82	2.24
Do	527.8	Aug. 4	173	0.73	113	27.92	2.34
Do	527.8	Aug. 7	108	0.61	55	27.03	1.45
Buffalo Flats	527.8	Aug. 8	82	0.63	45	26.81	1.23
Do	527.8	Aug. 9	72	0.63	40	26.67	1.09
Do	527.8	Aug. 13	53	0.58	25	26.41	0.83
Do	527.8	Aug. 14	50	0.53	22	26.39	0.81
		1873.					
Above Walnut Hills	534.5	Aug. 21	128	[a]0.28	38	27.83	1.09
Spoon Camp Shoals	535.8	....do ...	41	[a]1.48	52	27.96	1.01
Frenchport	543.3	Aug. 15	79	[a]1.10	60	28.43	0.97
Little Buffalo Shoals	547.5	Aug. 14	63	[a]0.72	35	28.60	0.99
Ravine Rapids	562.0	July 26	25	[a]0.89	14	29.20	0.80
		1897.					
Camden	564.4	May 5	111	0.65	59	29.86	1.35
Do	564.4	May 7	96	0.53	42	29.64	1.13
Do	564.1	June 7	313	0.97	244	32.13	3.68

[a] **Observations made with double float (?) and reduced to maximum mid-depth velocities.**

TABLE 7 B.—*Discharge observations in tributaries to Ouachita River.*

Locality.	Above mouth of tributary.	Date.	Area.	Maximum mid-depth velocities.	Discharge.	Elevation of water surface above Cairo datum.	Stage above low water.
Little River.	*Kilometers.*	1894.	*Sq. meters.*	*Meters per second.*	*Cu. meters.*	*Meters.*	*Meters.*
Near mouth	0.3	Nov. 20	26	0.11	2	8.60	0.58
Do	0.3	Nov. 21	26	0.35	7	8.66	0.64
Do	0.3	Nov. 23	26	0.26	5	8.63	0.61
Do	0.3	Nov. 24	26	0.34	7	8.66	0.64
Do	0.3	Nov. 26	26	0.30	6	8.63	0.31
Do	0.3	....do ...	26	0.32	7	8.61	0.59
		1896.					
Do	0.9	Nov. 20	37	0.67	23	9.10	1.10

TABLE 7 B.—*Discharge observations in tributaries to Ouachita River*—Continued.

Locality.	Above mouth of tributary.	Date.	Area.	Maximum mid-depth velocities.	Discharge.	Elevation of water surface above Cairo datum.	Stage above low water.
Tensas River.	*Kilometers.*	1894.	*Sq. meters.*	*Meters per second.*	*Cu. meters.*	*Meters.*	*Meters.*
Near mouth	0.2	Nov. 21	28	0.62	13	8.53	0.53
Do	0.2	Nov. 22	28	0.68	11	8,52	0.52
Do	0.2	Nov. 24	28	0.66	12	8.51	0.51
Do	0.2	Nov. 26	28	0.66	13	8.46	0.46
Do	0.2	Nov. 27	28	0.76	13	8.45	0.45
		1896.					
Near mouth	2.2	Nov. 20	15	0.67	9	9.10	1.10
		1898.					
In Mills Bayou	132.5	Nov. 17	27	0.36	6	18.82	2.12
Below Mills Bayou	132.4	Nov. 17	77	0.78	31	18.82	2.12
In Alligator Bayou	184.8	Oct. 7	22	0.35	5	....	....
	205.0	Sept. 22	68	0.21	7	24.10	2.10
Dallas	221.8	Sept. 13	15	0.07	1	22.23	0.00
Bayou Maçon.							
Near mouth	0.0	Dec. 20	87	0.54	30	14.79	2.29
Joes Bayou	128.4	Oct. 6	53	0.44	19	21.19	0.99
Delhi	140.7	Sept. 12	28	0.15	3	21.93	0.93
Boeuf River.							
		1896.					
Near mouth	0.0	Oct. 24	11	0.77	7	10.03	0.30
		1899.					
	11.8	Sept. 15	25	0.09	2	12.35	0.00
	22.6	Sept. 8	44	0.09	4	13.50	0.00
	32.6	Aug. 26	36	0.09	4	14.39	0.49
Joes Bayou	59.5	Aug. 18	39	0.10	4	15.40	0.10
Below Big Creek	73.0	Aug. 11	26	0.19	5	15.86	0.10
In Big Creek	73.8	Aug. 11	2	0.17	0.4	15.90	0.10
Above Big Creek	74.0	Aug. 11	12	0.24	3	15.87	0.10
Below Bayou La Fourche	83.3	Jan. 9	244	0.45	100	20.92	4.32
In Bayou La Fourche	83.5	Jan. 9	346	0.19	43	20.96	4.36
Above Bayou La Fourche	83.7	Jan. 9	224	0.28	55	20.93	4.33
		1898.					
Alto	162.6	Nov. 15	204	0.44	69	22.58	2.48
Myrick Island	184.2	Nov. 3	33	0.61	21	22.31	1.31
V., S. & P. R. R. bridge	195.6	Oct. 25	73	0.61	37	23.99	1.91
Do	195.6	Sept. 8	6	0.59	3	21.99	−0.09
Mann Place	238.8	Oct. 11	61	0.22	11	25.93	0.08
Bayou Bonne Idee	246.0	Oct. 14	4	0.09	0.4	26.81	....
Bayou Bartholomew.							
		1895.					
Marble Place	1.5	Nov. 14	21	0.34	4	18.94	0.57
		1899.					
De Siard	12.1	Sept. 29	18	0.22	4	21.01	0.1
Sandidge Place	24.2	Oct. 7	12	0.27	3	22.78	0.1
Williams Ferry	39.2	Oct. 14	22	0.17	3	24.46	0.1
Boones Ford	48.6	Oct. 19	22	0.19	4	25.48	0.1
Bonner Place	64.8	Oct. 27	19	0.17	3	27.05	0.1
Levy Place	81.9	Nov. 4	40	0.09	3	28.05	0.1
Level Place	89.4	Nov. 10	9	0.27	3	28.40	0.1
Newman Place	102.5	Nov. 17	38	0.09	3	29.52	0.1
Haynes Place	121.8	Dec. 1	43	0.09	4	30.22	0.1
Crawley Place	139.9	Dec. 9	30	0.09	2	31.00	0.3
Hadley Place	153.8	Dec. 15	19	0.21	4	32.06	0.3
Parkdale	172.3	Dec. 28	22	0.27	5	33.23	0.6
		1900.					
Sunshine Landing	189.8	Jan. 4	23	0.12	3	34.11	0.3
Wilson Place	211.1	Jan. 13	86	0.08	8	36.40	0.8
Moore Place	224.0	Jan. 19	44	0.11	5	36.58	0.6
Townsend Place	253.4	Feb. 2	26	0.09	3	37.83	0.4
Duke Place	270.9	Feb. 13	29	0.20	6	39.49	0.5
Baxter	291.5	Feb. 24	63	0.28	19	42.26	1.4

TABLE 8.—*Discharge and gauge relation.*

GAUGE AT CHAMPAGNOLLE.

Reading.[a]	Discharge.	Reading.[a]	Discharge.	Reading.[a]	Discharge.	Reading.[a]	Discharge.
Meters.	*Cubic meters per second.*	*Meters.*	*Cubic meters per second.*	*Meters.*	*Cubic meters per second.*	*Meters.*	*Cubic meters per second.*
24.0	11	25.6	89	27.4	194	29.0	338
24.2	20	25.8	101	27.6	210	29.2	370
24 4	29	26.0	113	27.8	226	29.4	409
24.6	38	26.2	126	28.0	243	29.6	449
24.8	48	26.4	138	28.2	260	29.8	490
25.0	58	26.8	151	28.4	278	30.0	533
25.2	69	27.0	165	28.6	298		
25.4	79	27.2	180	28.8	317		

[a] Gauge readings corrected to Cairo datum.

GAUGE AT MONROE.

Reading.	Discharge.	Reading.	Discharge.	Reading.	Discharge.	Reading.	Discharge.
Feet.	*Cubic meters per second.*	*Feet.*	*Cubic meters per second.*	*Feet.*	*Cubic meters per second.*	*Feet.*	*Cubic meters per second.*
0.5	16	7.5	189	19.0	520	33.0	1,084
1.0	26	8.0	203	20.0	553	33.5	1,117
1.5	32	8.5	216	21.0	584	34.0	1,152
2.0	42	9.0	231	22.0	619	34.5	1,188
2.5	56	9.5	243	23.0	652	35.0	1,230
3.0	71	10.0	257	24.0	686	35.5	1,280
3.5	82	11.0	284	25.0	720	36.0	1,334
4.0	96	12.0	314	26.0	756	36.5	1,410
4.5	109	13.0	343	27.0	795	37.0	1,528
5.0	122	14.0	372	28.0	835	37.5	1,880
5.5	137	15.0	400	29.0	879	38.0	2,000
6.0	149	16.0	433	30.0	924		
6.5	163	17.0	460	31.0	974		
7.0	177	18.0	490	32.0	1,024		

GAUGE AT CATAHOULA SHOALS.

Reading.[a]	Discharge.	Reading.[a]	Discharge.	Reading.[a]	Discharge.	Reading.[a]	Discharge.
Meters.	*Cubic meters per second.*	*Meters.*	*Cubic meters per second.*	*Meters.*	*Cubic meters per second.*	*Meters.*	*Cubic meters per second.*
9.0	4	9.6	28	10.2	63	10.8	141
9.2	12	9.8	36	10.4	89	11.0	170
9.4	20	10.0	48	10.6	114	12.0	280

[a] Gauge readings corrected to Cairo datum.

GAUGE AT MOUTH OF BLACK RIVER.

Reading.[a]	Discharge.	Reading.[a]	Discharge.	Reading.[a]	Discharge.	Reading.[a]	Discharge.
Meters.	*Cubic meters per second.*	*Meters.*	*Cubic meters per second.*	*Meters.*	*Cubic meters per second.*	*Meters.*	*Cubic meters per second.*
8.0	68	9.8	176	13.4	427	17.0	858
8.2	81	10.0	188	13.6	444	17.5	937
8.4	92	10.5	218	13.8	463	18.0	1,022
8.6	103	11.0	247	14.0	481	18.2	1,062
8.8	115	11.5	281	14.5	531	18.4	1,098
9.0	127	12.0	316	15.0	590	18.6	1,136
9.2	139	12.5	353	15.5	646	18.8	1,174
9.4	152	13.0	394	16.0	710	19.0	1,214
9.6	164	13.2	410	16.5	779		

[a] Gauge readings corrected to Cairo datum.

TABLE 9.—*Sediment observations in Ouachita and Black rivers, Arkansas and Louisiana.*

Locality.	Distance from mouth of Black River.	Date.	Elevation water surface, Cairo datum.	Per cent of sediment.				Stage above low water of 1896.	Change in water surface per hour for previous 24 hours.	
				Surface.	Mid-depth.	Bottom.	Mean.		Rise.	Fall.
	Kilometers.		*Meters.*					*Meters.*	*Millimeters.*	*Millimeters.*
Near mouth of Black River, Louisiana	0.6	Dec. 22, 1896	11.52	0.005	0.004	0.005	0.005	3.98	....	9.3
Do	....	Mar. 14, 1893	19.06	0.001	0.001	0.007	0.003	11.52	Amount (?).	
Do	....	Dec. 21, 1891	10.59	0.008	0.016	0.009	0.011	3.05	....	1.7
Do	....	July 26, 1891	13.59	0.009	0.010	0.006	0.008	6.05	....	6.1
Lanius Place, La	6.0	Dec. 19, 1896	12.22	0.005	0.001(?)	0.005	0.004	4.65	....	8.0
1.6 kilometers below Beards Landing, La	40.2	Dec. 9, 1896	12.43	0.006	0.006	0.006	0.006	4.72	8.2	....
Harrisonburg, La	117.7	Nov. 11, 1896	9.4	0.005	0.004	0.005	0.005	1.17	....	1.5
Harrisonburg, La	....	Oct. 30, 1896	8.9	[a]0.015	[a]0.014	[a]0.016	[a]0.015	0.67	5.8	....
Cottingham Landing, La	158.9	Oct. 15, 1896	10.13	0.003	0.002	0.004	0.003	0.15	....	0.2
Wade Place, La	189.9	Oct. 7, 1896	10.25	0.003	0.002	0.002	0.002	0.04	0.9	....
Columbia, La	201.0	Oct. 1, 1896	10.52	0.005	0.004	0.004	0.004	0.04	....	0.8
Do	....	Dec. 28, 1895	15.15	0.030	0.029	0.029	0.029	4.67	17.1	....
Watkins Place, La	256.1	Dec. 12, 1895	16.07	....	0.004	0.005	0.004	2.10	....	6.7
Logtown, La	260.1	Dec. 11, 1895	16.42	0.002	0.002	0.005	0.003	2.23	....	4.6
Monroe, La	294.9	Apr. 21, 1897	26.81	0.002	0.001	0.002	0.002	11.05	....	1.5
Do	....	Apr. 19, 1897	26.89	0.002	0.003	0.005	0.003	11.13	....	1.8
Do	....	Apr. 13, 1897	27.13	0.002	0.004	0.025	0.010	11.37	....	0.8
Do	....	Apr. 10, 1897	27.17	0.002	0.002	0.004	0.003	11.41	Stand.	
Do	....	Apr. 7, 1897	27.13	0.001	0.004	0.004	0.003	11.37	1.4	....
Do	....	Apr. 5, 1897	27.06	0.004	0.007	0.025	0.012	11.30	2.7	....
Do	294.9	Mar. 30, 1897	26.39	0.001	0.003	0.009	0.004	10.63	7.2	....
Ouachita City, La	337.9	Nov. 14, 1895	18.60	0.003	0.003	0.003	0.003	0.26	1.2	....
Mallard Shoals, La	372.6	Oct. 26, 1895	19.45	0.003	0.003	0.002	0.003	0.22	....	0.4
Eutaw Rapids, Ark	430.7	Oct. 11, 1895	21.19	0.005	0.004	0.005	0.005	0.29	Stand.	
Romeo Shoals, Ark	455.4	Oct. 2, 1895	23.33	0.006	0.006	0.005	0.006	0.41	0.8	....
2 kilometers above Wilmington, Ark	470.5	Sept. 25, 1895	23.56	0.002	0.002	0.002	0.002	0.51	Stand.	
Eldorado Shoals, Ark	494.6	June 29, 1897	24.51	0.001	0.001	....	0.001	0.55	0.5	....
Haidee Shoals, Ark	506.6	June 25, 1897	25.65	....	0.001	0.001	0.001	0.77	....	2.1
Newport Landing, Ark	527.0	June 19, 1897	26.40	0.004	0.002	0.002	0.003	0.86	....	2.1

[a] Taken next day after heavy rain.

TABLE 10.—*Borings in Ouachita and Black rivers, Arkansas and Louisiana.*

BORING NO. 1.—NEW HOPE PLACE, LOUISIANA.

[37.9 miles above mouth of Black River. Elevation of channel, 6.77 M. C. D.]

Depth.	Elevation.		Character of material.
	Mean Gulf level.	Cairo datum.	
Feet.	*Feet.*	*Meters.*	
0.00	1.94	6.77	Sandy clay.
6.57	− 4.63	4.77	Sand and lumps of mud.
9.85	− 7.91	3.77	Dark sand.
41.02	−39.08	−5.73	Do.

BORING NO. 1A.

0.00	5.05	7.72	Sandy clay.
3.93	1.12	6.53	Dark gray sand.
12.47	− 7.42	3.92	Dark sand and mud.
14.11	− 9.06	3.42	Blue mud.
18.21	−13.16	2.17	Mud and sand.
29.53	−24.48	−1.28	Dark sand.
39.37	−34.32	−4.28	Do.

BORING NO. 2.—STAR VIEW PLACE, LOUISIANA.

[42.2 miles above mouth of Black River. Elevation of channel, 6.33 M. C. D.]

0.00	7.87	8.58	Brown sand and mud.
6.58	1.31	4.77	Gray sand.
50.00	−42.13	−6.66	Do.

BORING NO. 3.—JONES BAYOU, LOUISIANA.

[51.4 miles above mouth of Black River. Elevation of channel, 6.58 M. C. D.]

0.00	6.37	8.12	Gray brown sand.
9.85	− 3.48	5.12	Clean gray sand.
50.01	−43.64	−7.12	Do.

BORING NO. 4.—CATAHOULA SHOALS, LOUISIANA.

[77.0 miles above mouth of Black River. Elevation of channel 7.88 M. C. D.]

0.00	11.06	9.55	Sandy mud.
0.99	10.07	9.25	Sand, clay, and gravel.
3.28	7.78	8.55	Gravel.
15.75	− 4.69	4.75	Gray sand.
30.35	− 19.29	0.30	Blue-brown sandy clay.
52.50	− 41.44	− 6.45	Blue-gray rock.
54.33	− 43.27	− 7.01	Very hard blue-gray clay or soft rock.
76.18	− 65.12	−13.67	Soft blue-gray rock.
86.32	− 75.26	−16.76	Blue sandy clay.
139.67	−128.61	−33.02	Gray rock.
140.00	−128.94	−33.12	Blue sandy clay.
158.07	−147.01	−38.63	Fine gray sand. From this sand water flowed at rate of 3,600 gallons per hour.
197.51	−186.45	−50.65	Do.

BORING NO. 4a.

0.00	10.86	9.49	Gray sand and gravel.
3.77	7.09	8.24	Dark sand and mud.
5.25	5.61	7.89	Sand, mud, and gravel.
6.56	4.30	7.49	Coarse sand.
11.65	−0.79	5.94	Stiff blue clay with small gravel.
14.64	−3.78	5.09	Do.

TABLE 10.—*Borings in Ouachita and Black rivers, Arkansas and Louisiana*—Continued.

BORING NO. 4b.

Depth.	Elevation.		Character of material.
	Mean Gulf level.	Cairo datum.	
Feet.	*Feet.*	*Meters.*	
0.00	5.28	7.78	Gray sand.
5.28	0.00	6.18	Sand and shells.
6.26	− 0.98	5.88	Mud in lumps.
13.15	− 7.87	3.78	Mud and sand.
15.62	−10.34	3.03	Mud and broken stone.
23.49	−18.21	0.63	Do.

BORING NO. 5.—WAINWRIGHT PLACE, LOUISIANA.

[105.6 miles above mouth of Black River. Elevation of channel 7.31 M. C. D.]

0.00	3.71	7.31	Yellowish sand and clay.
4.92	− 1.21	5.81	Yellowish sand.
6.56	− 2.85	5.31	Sand; small per cent of yellow-gray clay.
9.85	− 6.14	4.31	Brown-red mud with small per cent of sand.
13.78	−10.07	3.11	Red-brown mud.
18.05	−14.34	1.81	Mud and clay.
19.67	−15.98	1.31	Gray sand.
36.09	−32.38	−3.69	Do.

BORING NO. 6.—STANFIELD PLACE, LOUISIANA.

[123.3 miles above mouth of Black River. Elevation of channel 8.50 M. C. D.]

0.00	14.93	10.73	Yellowish sand and clay.
1.62	13.29	10.23	Yellowish sand.
19.69	− 4.76	4.73	Mud with gray sand.
22.31	− 7.38	3.93	Gray sand.
25.10	−10.17	3.08	Mud with dark sand.
41.01	−26.08	− 1.77	Sand.
43.47	−28.54	− 2.52	Mud with sand.

BORING NO. 7.—COLUMBIA, LA.

[125.6 miles above mouth of Black River. Elevation of channel 8.48 M. C. D.]

0.00	18.47	11.81	Reddish-yellow sand and clay.
8.20	10.27	9.31	Reddish-yellow sand.
9.84	8.63	8.81	Gray sand.
15.75	2.72	7.01	Mud with sand.
17.39	1.08	6.51	Dark-gray sand.
24.28	− 5.81	4.41	Mud with small per cent of sand.
24.61	− 6.14	4.31	Gray sand.
29.03	−10.56	2.96	Mud with gray sand.
32.31	−13.84	1.96	Gray sand.
36.58	−18.11	0.66	Sand with small per cent of mud.
40.68	−22.21	− 0.59	Gray sand.
50.59	−32.12	− 3.69	Mud and sand.
52.49	−34.02	− 4.19	Do.

BORING NO. 8.—ABOVE COLUMBIA, LA.

[126.9 miles above mouth of Black River. Elevation of channel, 9.03 M. C. D.]

0.00	20.01	12.28	Brown sand and clay.
16.41	3.60	7.28	Gray sand.
32.81	− 12.80	2.28	Gray-brown sand.
48.23	− 28.22	− 2.42	Blue-gray sand, with small per cent of clay and pieces of coal.
73.43	− 53.42	−10.10	Blue-gray sand, with some clay and gravel.
100.03	− 80.02	−18.21	Clay, with small per cent of sand and pieces of rock.
113.19	− 93.18	−22.22	Very coarse sand and clay.
120.47	−100.46	−24.44	Gray sand.
177.07	−157.06	−41.69	Gray sand, with small per cent of clay.
220.14	−200.13	−54.82	Do.

TABLE 10.—*Borings in Ouachita and Black rivers, Arkansas and Louisiana*—**Continued.**

BORING NO. 9.—ABOVE COLUMBIA, LA.

[127.5 miles above mouth of Black River. Elevation of channel, 10.01 M. C. D.]

Depth.	Elevation.		Character of material.
	Mean Gulf level.	Cairo datum.	
Feet.	*Feet.*	*Meters.*	
0.00	27.78	14.65	Soft, boggy sand and mud full of trash.
24.60	3.18	7.15	Gray sand with bark and wood.
47.57	--19.79	0.15	Gray sand.

BORING NO. 10.—ABOVE COLUMBIA, LA.

[128.1 miles above mouth of Black River. Elevation of channel, 4.36 M. C. D.]

0.00	23.81	13.44	Brown sand and clay.
17.02	6.79	8.25	Gray brown sand with some clay.
52.49	−28.68	−2.56	Gray brown sand with some clay.

BORING NO. 11.—SMITHLAND, LA.

[131.2 miles above mouth of Black River. Elevation of channel, 9.84 M. C. D.]

0.00	19.19	12.03	Brown sand with some clay.
9.84	9.35	9.03	Log.
10.50	8.69	8.83	Gray sand with small per cent of clay.
16.41	2.78	7.03	Clean gray sand.
21.33	− 2.14	5.53	Gray brown sand.
32.81	−13.62	2.03	Gray sand with clay in lumps or layers.
34.16	−14.97	1.01	Gray sand with larger per cent of clay.
46.03	−26.84	−2.00	Coal.
46.69	−27.50	−2.20	Gray sand and some clay.

BORING NO. 12.—LOWER BRESTON PLACE, LOUISIANA.

[132.2 miles above mouth of Black River. Elevation of channel, 9.12 M. C. D.]

0.00	12.82	10.09	Very soft sand and mud.
9.84	2.98	7.09	Brown sand with small per cent of clay.
13.12	− 0.30	6.09	Lot of trash, principally wood.
16.40	− 3.58	5.09	Fine clean gray sand.
19.68	− 6.86	4.09	Coarse clean gray sand.
47.57	−34.75	−4.41	Coarse clean gray sand.

BORING NO. 13.—UPPER BRESTON PLACE, LOUISIANA.

[133.3 miles above mouth of Black River. Elevation of channel, 9.34 M. C. D.]

0.00	16.99	11.36	Brown sand and mud.
16.40	0.59	6.36	Fine gray sand full of trash.
34.78	−17.79	0.76	Coarse gray sand.
44.06	−27.07	−2.07	Stiff blue mud with some sand and pieces of rock.
52.59	−35.60	−4.37	Stiff blue mud with some sand and pieces of rock.

BORING NO. 13a.

0.00	17.81	11.61	Soft brown sand.
16.40	1.41	6.61	Fine gray sand with some trash.
32.81	--15.00	1.61	Coarse gray sand.
47.64	--29.83	−2.91	Stiff blue mud with some sand and pieces of rock.
52.49	−34.68	−4.39	Stiff blue mud with some sand and pieces of rock.

Table 10.—*Borings in Ouachita and Black rivers, Arkansas and Louisiana*—Continued.

BORING NO. 14.—CALLS LANDING, LOUISIANA.

[134.5 miles above mouth of Black River. Elevation of channel, 10.29 M. C. D.]

Depth.	Elevation.		Character of material.
	Mean Gulf level.	Cairo datum.	
Feet.	*Feet.*	*Meters.*	
0.00	16.21	11.12	Brown sand with some clay.
9.84	6.37	8.12	Gray sand.
31.08	−24.87	−1.40	Stiff gray blue sand and clay.
50.86	−34.65	−4.38	Stiff gray blue sand and clay.

BORING NO. 14a.

0.00	14.40	10.57	Brown sandy clay.
6.56	7.84	8.57	Gray sand.
39.76	−25.36	−1.55	Stiff gray blue sand and clay.
50.00	−35.60	−4.67	Stiff gray blue sand and clay.

BORING NO. 15.—NEAR BLANKSTON, LA.

[143.5 miles above mouth of Black River. Elevation of channel, 8.8 M. C. D.]

0.00	27.0	14.4	Stiff red clay.
19.7	7.3	8.4	Sandy clay.
22.4	4.6	7.6	Coarse gray sand with small percentage of clay.
26.3	0.7	6.4	Gray sand.
41.4	−14.4	1.8	Black sand and clay.
51.2	−24.2	−1.2	Do.

BORING NO. 16.

[144.5 miles above mouth of Black River. Elevation of channel, 10.55 M. C. D.]

0.00	29.26	15.10	Brown sand with small percentage of clay.
27.89	1.37	6.60	Gray sand with some clay.
50.00	−20.74	−0.14	Stiff clay with some sand.

BORING NO. 17.

0.00	21.26	12.66	Dark gray sand and clay.
16.41	4.85	7.66	Sand and clay.
19.69	1.57	6.66	Gray sand and clay.
43.38	−22.12	−0.56	Stiff, sticky blue clay with small percentage of sand.
50.00	−28.74	−2.58	Stiff and very sticky blue clay.

BORING NO. 17a.

0.00	27.33	14.51	Sand and clay.
1.65	25.68	14.01	Brown sand.
13.13	14.20	10.51	Gray sand.
34.29	− 6.96	4.06	Gray sand with small percentage of clay.
42.66	−15.83	1.51	Gray sand with larger percentage of clay.
50.00	−22.67	−0.73	Gray sand with still larger percentage of clay.

TABLE 10.—*Borings in Ouachita and Black rivers, Arkansas and Louisiana*—Continued.

BORING NO. 18.—BOSCO, LA.

[155 miles above mouth of Black River. Elevation of channel, 10.97 M. C. D.]

Depth.	Elevation.		Character of material.
	Mean Gulf level.	Cairo datum.	
Feet.	*Feet.*	*Meters.*	
0.00	25.13	13.84	Yellow sand.
13.12	12.01	9.84	Gray sand with small per cent of clay.
36.09	−10.96	2.84	Mud.
43.96	−18.33	0.44	Mud with small per cent of sand.

BORING NO. 18a.

0.00	15.72	10.97	Fine clean sand.
4.43	11.29	9.62	Fine gray sand and mud.
17.06	− 1.34	5.77	Coarse gray sand and blue mud with gravel.
17.56	− 1.84	5.62	Clean gray sand.
23.46	− 7.74	3.82	Gray sand and mud.
24.78	− 9.06	3.42	Mud with small per cent of sand.
25.10	− 9.38	3.32	Mud.
32.14	−16.42	1.17	Do.

BORING NO. 19.—NEAR LOGTOWN, LA.

[160.1 miles above mouth of Black River. Elevation of channel, 12.77 M. C. D.]

0.00	29.29	15.11	Brown sand and trash.
1.64	27.65	14.61	Brown sand.
13.12	16.17	11.11	Sand and coarse gravel.
23.78	5.51	7.86	Very stiff, sticky, blue-black clay.
37.73 to 50.00	− 8.44 to −20.71	3.61 to − 0.13	Very stiff blue-black clay, with pockets and streaks of green sand and shells, also many small pieces of rock, some as large as hen egg.

BORING NO. 19a.

0.00	37.17	17.51	Brown sandy clay.
1.97	35.20	16.91	Brown sand.
13.13	24.04	13.51	White sand.
19.69	17.48	11.51	Sand and coarse gravel.
28.12	9.05	8.94	Sand and coarse gravel with small per cent of clay.
34.78	2.39	6.91	Stiff, sticky blue-black clay.
42.65	− 5.48	4.51	Very stiff clay with pockets and streaks of greensand marl.
49.22 to 50.00	−12.05 to −12.83	2.51 to 2.27	Very stiff clay with pockets and streaks of greensand marl; also several pieces of rock about the size of hen egg.

BORING NO. 19b.—MONROE, LA.

[183.4 miles above mouth of Black River. Elevation of channel, 14.83 M. C. D.]

0.00	40.51	18.53	Brown sand.
30.84	9.67	9.13	Gray sand and gravel.
39.99	0.52	6.34	Blue-black clay and sand.
45.63	− 5.12	4.62	Rock.

BORING NO. 20.

0.00	37.99	17.76	Brown sand.
17.39	20.60	12.46	Gray sand.
40.22	− 2.73	5.35	Blue-black clay and sand.
51.38	−13.89	2.10	Do.

TABLE 10.—*Borings in Ouachita and Black rivers, Arkansas and Louisiana*—Continued.

BORING NO. 20a.

Depth.	Elevation.		Character of material.
	Mean Gulf level.	Cairo datum.	
Feet.	*Feet.*	*Meters.*	
0.00	44.22	19.68	Brown sand and clay.
3.28	40.94	18.66	Brown sand.
22.96	21.26	12.66	Grayish sand.
36.28	7.94	8.60	Blue-black clay with some sand.
50.20	—5.98	4.36	Do.

BORING NO. 20b.

0.00	27.79	14.65	Yellow sand and mud.
6.56	21.23	12.65	Gray sand.
22.31	5.48	7.85	Coarse sand mixed with gravel and mud.
23.95	3.84	7.35	Coarse bits of broken gravel and sand.
25.59	2.20	6.85	Sand.
27.23	0.56	6.35	Fine sand and mud.
28.55	— 0.76	5.95	Mud.
31.50	— 3.71	5.05	Blue mud.
33.79	— 6.00	4.35	Mud and sand.
36.42	— 8.63	3.55	Mud.
41.01	—13.22	2.15	Mud and sand.
43.97	—16.18	1.25	Do.

BORING NO. 20c.

0.00	34.06	16.56	Clean white sand.
5.26	28.80	14.96	Yellow sand.
5.58	28.48	14.86	Wet brown sand.
5.91	28.15	14.76	Wet black sand.
12.47	21.59	12.76	Gray sand.
35.86	—1.80	5.63	Fine sand and mud.
39.77	—5.71	4.44	Blue clay.

BORING NO. 21.—ROCK ROW SHOALS, LOUISIANA.

[200.9 miles above mouth of Black River. Elevation of channel, 18.18 M. C. D.]

0.00	41.56	18.85	Brown-gray sand with small per cent of clay.
1.64	39.92	18.35	Brown sand.
24.27	17.29	11.45	Very stiff clay and green-sand marl.
49.70	— 8.14	3.70	Very stiff clay and green-sand marl with a few shells.
62.73	— 21.17	— 0.27	Rock.
62.99	— 21.43	— 0.35	Very stiff clay and green-sand marl with a few shells.
69.62	— 28.06	— 2.37	Same clay with more green-sand and pieces of rounded rock, size 1 inch.
70.99	— 29.43	— 2.79	Rock.
71.68	— 30.12	— 3.00	Green-sand with small per cent of clay.
74.45	— 33.89	— 4.15	Green-sand and clay.
78.74	— 37.18	— 5.15	Stiff clay with some green-sand and a few small shells.
82.02	— 40.46	-- 6.15	Very stiff blue-black clay with a few small shells.
102.39	— 60.83	—12.36	Rock.
102.72	— 61.16	—12.46	Very stiff blue-black clay with a few small shells.
117.97	— 76.41	—17.11	Very stiff dark-brown clay and sand with some shells.
126.31	— 84.75	—19.65	Gray rock, very hard and full of shells.
126.46	— 85.90	—20.00	Dark-gray sand and clay with shells.
131.36	— 89.80	—21.19	Rock.
131.69	— 90.13	—21.29	Blue-black clay with shells and sand.
146.78	—105.12	—25.86	Gray and green rock full of shells.
149.14	—107.58	—26.61	Very stiff clay with shells and pockets of sand.
153.70	—112.14	—28.00	Gray-green rock full of shells.
155.02	—113.46	—28.40	Very stiff clay with shells and sand.
156.39	—114.83	—28.82	Gray-green rock full of shells.
157.05	—115.49	—29.02	Do.

TABLE 10.—*Borings in Ouachita and Black rivers, Arkansas and Louisiana*—Continued.

BORING NO. 21a.

Depth.	Elevation.		Character of material.
	Mean Gulf level.	Cairo datum.	
Feet.	*Feet.*	*Meters.*	
0.00	39.07	18.09	Brown gray sand and mud.
16.40	22.67	13.09	Green sand marl with large per cent of clay.
40.35	− 1.28	5.79	Stratum of rock about 1 inch thick.
48.49	− 9.42	3.31	Very stiff green sand and clay.
62.79	−23.72	−1.05	Very stiff mud or soft rock.

BORING NO. 22.—LOCH LOMOND, LOUISIANA.

[205.0 miles above mouth of Black River. Elevation of channel, 17.52 M. C. D.]

0.00	48.78	21.05	Brown sand with small per cent of gravel.
20.47	28.31	14.81	Green sand marl with medium per cent of clay.
34.48	14.30	10.54	Green sand marl with small per cent of clay.
42.16	6.62	8.20	Very stiff green sand and mud.
50.00	−1.22	5.81	Do.

BORING NO. 22a.

0.00	47.47	20.65	Brown sand and mud.
0.99	46.48	20.35	Brown sand with small per cent of gravel.
13.88	33.59	16.42	Green sand marl with large per cent of clay.
32.68	14.79	10.69	Green sand marl with small per cent of clay.
39.37	8.10	8.65	Very stiff green sand and mud.
50.00	−2.53	5.41	Do.

BORING NO. 23.—ROLAND RAFT, ARKANSAS.

[240.6 miles above mouth of Black River. Elevation of channel, 16.53 M. C. D.]

0.00	51.08	21.75	Brownish sand.
23.23	27.85	14.67	Gravel.
35.57	15.51	10.91	Gray sand.
63.98	−12.90	2.25	Very stiff blue black clay.
64.58	−13.55	2.05	Rock.
64.96	−13.88	1.95	Very stiff blue black clay.
68.90	−17.82	0.75	Do.

BORING NO. 23a.

0.00	48.55	20.98	Brownish sand.
9.84	38.71	17.98	Grayish sand.
20.67	27.88	14.68	Gravel.
30.22	18.33	11.77	Grayish sand.
50.00	−1.45	5.74	Do.

BORING NO. 24.—MARIE SALINE LANDING, ARKANSAS.

[253.5 miles above mouth of Black River. Elevation of channel, 19.19 M. C. D.]

0.0[illegible]	46.56	20.37	Yellowish sand and clay.
1.[illegible]	44.92	19.87	Yellowish sand.
4.[illegible]	42.45	19.12	Light gray sand.
18.[illegible]8	28.18	14.77	Mud and sand.
35.44	11.12	9.57	Do.

TABLE 10.—*Borings in Ouachita and Black rivers, Arkansas and Louisiana*—Continued.

BORING NO. 25.—PERIGEETHE SHOALS, ARKANSAS.

[269.7 miles above mouth of Black River. Elevation of channel, 20.14 M. C. D.]

Depth.	Elevation.		Character of material.
	Mean Gulf level.	Cairo datum.	
Feet.	*Feet.*	*Meters.*	
0.00	52.26	22.11	Brown sand.
9.84	42.42	19.11	Gray sand and gravel.
12.24	40.02	18.38	Log.
21.56	30.70	15.54	Gray sand.
32.06	20.20	12.34	Gray sand with small per cent of clay.
50.00	2.26	6.87	Do.

BORING NO. 25a.

0.00	58.89	24.13	Yellowish sand and clay.
3.55	51.34	21.83	Yellow sand and gravel with very small per cent of clay.
19.69	39.20	18.13	Gray sand and gravel with very small per cent of clay.
50.00	8.89	8.89	Do.

BORING No. 25b.—YERRICKS SLOUGH, ARKANSAS.

[276.7 miles above mouth of Black River. Elevation of channel, 20.67 M. C. D.]

0.00	58.69	24.07	Yellow sandy clay.
4.59	54.10	22.67	Yellowish sand.
7.87	50.82	21.67	Gray sand.
12.63	46.06	20.22	Broken shells.
13.28	45.41	20.02	Gray sand, mud, and broken shells.
15.58	43.11	19.32	Light gray sand.
17.22	41.47	18.82	Broken shells.
18.53	40.16	18.42	Sand and broken shells.
22.14	36.55	17.32	Light gray sand.
32.80	25.89	14.07	Gray sand.

BORING NO. 26.—JACKS ISLAND, ARKANSAS.

[278.4 miles above mouth of Black River. Elevation of channel, 21.36 M. C. D.]

0.00	50.03	21.43	Sand, mud, and leaves.
3.28	46.75	20.43	Gray sand with very small per cent of clay.
75.62	−25.59	− 1.62	Gray sand with few small lumps of blue mud.
90.22	−40.19	− 6.07	Very fine white sand with small per cent of white clay.
97.97	−47.94	− 8.43	Gray sand.
104.99	−54.96	−10.57	White sand with small per cent of white clay.
108.27	−58.24	−11.57	Gray sand.
124.61	−74.58	−16.55	White sand.
132.94	−82.91	−19.09	Gray sand.
135.17	−85.14	−19.77	Apparently a log; wash very dark, and substance resembles rotten wood.
143.44	− 93.41	−22.29	White sand.
144.38	− 94.35	−22.57	White sand with small per cent of clay.
145.70	− 95.67	−22.98	White sand.
150.04	−100.01	−26.13	Blue-gray clay, with pockets and streaks of sand.
201.34	−151.31	−39.94	Hard, brownish rock.
201.97	−151.94	−40.14	Blue-gray clay, with pockets and streaks of sand.
202.59	−152.56	−40.26	Do.

BORING NO. 26a.

0.00	57.54	23.72	Sand and gravel.
10.43	47.11	20.54	Gray sand.
50.00	7.54	8.48	Do.

TABLE 10.—*Borings in Ouachita and Black rivers, Arkansas and Louisiana*—Continued.

BORING NO. 26b.

Depth.	Elevation.		Character of material.
	Mean Gulf level.	Cairo datum.	
Feet.	*Feet.*	*Meters.*	
0.00	53.22	22.40	Yellow sandy clay.
3.94	49.28	21.20	Yellow sand.
5.25	47.97	20.80	Sand and gravel.
6.57	46.65	20.40	Blue mud.
7.88	45.34	20.00	Sand and mud.
12.31	40.91	18.65	Light gray sand.
17.39	35.83	17.10	Mud.
19.69	33.53	16.40	Light gray sand.
30.52	22.70	13.10	Do.

BORING NO. 27.—FRANKLIN SHOALS, ARKANSAS.

[298.6 miles above mouth of Black River. Elevation of channel 22.59 M. C. D.]

0.00	54.82	22.89	Sand and gravel.
6.56	48.26	20.89	Stiff blue mud, with pockets and streaks of sand.
50.00	4.82	7.65	Do.

BORING NO. 27a.

0.00	55.64	23.14	Gravel and sand.
8.20	47.44	20.64	Stiff blue mud, with pockets and streaks of sand.
50.00	5.64	7.90	Do.

BORING NO. 28.—SMACKOVER SHOALS, ARKANSAS.

[313.4 miles above mouth of Black River. Elevation of channel, 23.55 M. C. D.]

0.00	56.99	23.55	Yellowish sandy clay.
1.64	55.35	23.05	Gray sand.
3.28	53.71	22.55	Gravel and sand.
4.10	52.89	22.30	Shells, sand, and mud.
4.92	52.07	22.05	Shells, sand, and gravel.
5.74	51.25	21.80	Sand and mud.
24.61	32.38	16.05	Blue mud and sand.
27.40	29.59	15.20	Blue mud with a little sand.
33.14	23.85	13.55	Mud and sand.

BORING NO. 29.—HAIDEE SHOALS, ARKANSAS.

[316.2 miles above mouth of Black River. Elevation of channel, 21.29 M. C. D.]

0.00	49.57	21.29	Gray sand and gravel.
9.84	39.73	18.29	Blue-gray clay.
46.59	2.98	7.09	Clean gray sand.
54.53	−4.96	4.67	Do.

BORING NO. 29a.

0.00	58.30	23.95	Gravel.
5.12	53.18	22.39	Sand and gravel.
7.71	50.59	21.60	Sand with some mud.
9.52	48.78	21.05	Blue clay.
13.13	45.17	19.95	Gray sand.
18.25	40.05	18.39	Gray sandy mud.
21.03	37.27	17.54	Grayish-blue clay.
29.53	28.77	14.95	Clean gray sand.
48.23	10.07	9.25	Do.

TABLE 10.—*Borings in Ouachita and Black rivers, Arkansas and Louisiana*—Continued.

BORING NO. 30.—NEWPORT LANDING, ARKANSAS.

[328.8 miles above mouth of Black River. Elevation of channel, 22.37 M. C. D.]

Depth.	Elevation.		Character of material.
	Mean Gulf level.	Cairo datum.	
Feet.	*Feet.*	*Meters.*	
0.00	63.61	25.57	Brown sandy clay.
7.05	56.56	23.42	Blue-black clay with sand.
8.69	54.92	22.92	Stiff blue-black clay with small pieces of rock.
11.16	52.45	22.17	Clean gray sand.
15.58	48.03	20.82	Stiff clay with gravel and sand.
22.97	40.64	18.57	Clay, with pockets and streaks of sand.
40.03	23.58	11.37	Same; also one tooth, apparently shark's.
109.55	−45.94	−7.82	Clay, with pockets and streaks of sand.

BORING NO. 30a.

0.00	60.03	24.48	Yellow-brown clay.
0.98	59.05	24.18	Brown sand.
3.41	56.62	23.44	Gray sand.
11.81	48.22	20.88	Blue-black clay, full of chips of rock.
19.12	40.91	18.65	Clay with pockets and streaks of sand.
50.00	10.03	9.24	Do.

BORING NO. 30b.

0.00	54.88	22.91	Brown sandy clay.
7.54	47.34	20.61	Blue-black clay with sand and gravel.
14.60	40.28	18.46	Blue-black clay with pockets and streaks of sand.
50.00	4.88	7.67	Gray-black clay.

BORING NO. 30c.

0.00	70.86	27.78	Very stiff brown clay.
4.10	66.76	26.53	White sandstone.
4.26	66.60	26.48	Sand impregnated with leaching of asphalt or bitumen.
6.56	64.30	25.78	Green sandy clay.
13.32	57.54	23.72	Clean gray sand.
13.55	57.31	23.65	Blue-gray sandy clay.
15.06	55.80	23.19	Sand with clay.

BORING NO. 30d.

0.00	63.61	25.57	Brown sandy clay.
7.05	56.56	23.42	Blue-black clay with sand.
8.69	54.92	22.92	Stiff blue-black clay with small pieces of rock.
11.16	52.45	22.17	Clean gray sand.
16.40	47.21	20.57	Stiff blue-black clay.
22.97	40.64	18.57	Clay with pockets and streaks of sand.
32.89	30.72	15.85	Stiff blue-black clay with pockets and streaks of sand.
35.14	28.47	14.86	Do.

BORING NO. 30e.—BEECH HILL, ARKANSAS.

[329.3 miles above mouth of Black River. Elevation of channel, 22.78 M. C. D.]

0.00	62.34	25.18	Mud.
3.28	59.06	24.18	White sand.
7.71	54.63	22.83	Gray sand.
8.70	53.64	22.53	Blue mud and sand.
9.36	52.98	22.33	Red-brown clay and sand.
10.01	52.33	22.13	Stiff blue mud.
15.26	47.08	20.53	Hard blue clay.

TABLE 10.—*Borings in Ouachita and Black rivers, Arkansas and Louisiana*—Continued.

BORING NO. 31.—BUFFALO FLATS, ARKANSAS.

[329.7 miles above mouth of Black River. Elevation of channel, 25.7 M. C. D.]

Depth.	Elevation.		Character of material.
	Mean Gulf level.	Cairo datum.	
Feet.	*Feet.*	*Meters.*	
0.0	64.4	25.8	Sandy clay.
3.0	61.4	24.9	Sand and gravel.
5.6	58.8	24.1	Sand, gravel, and shells.
10.6	53.8	22.6	Gravel and green sandstone.
11.2	53.2	22.4	Soft green sandstone.
12.2	52.2	22.1	Stiff blue mud.
19.7	44.7	19.8	Mud and sand.
23.0	41.4	18.8	Sand.
26.0	38.4	17.9	Quicksand.
28.6	35.8	17.1	Sand with clay.
30.9	33.5	16.4	Green mud with sand.
31.9	32.5	16.1	Sand and mud.
35.8	28.6	14.9	Sandstone.
36.1	28.3	14.8	Sand and mud.
36.5	27.9	14.7	Sand.
43.3	21.1	12.6	Red stone.
45.0	19.4	12.1	Sand.
49.6	14.8	10.7	Sand and mud.
55.2	9.2	9.0	Sand, mud, and coal.
55.8	8.6	8.8	Red sandstone.
59.4	5.0	7.7	Sand and mud.
69.9	− 5.5	4.5	Gravel or conglomerate.
70.2	− 5.8	4.4	Grindstone rock.
71.6	− 7.2	4.0	Through stratum of grindstone rock.

BORING NO. 31a.

0.0	64.1	25.7	Yellowish sand and mud.
1.6	62.5	25.2	Do.
3.6	60.5	24.6	Yellowish sand, mud, and gravel.
7.7	56.4	23.4	Indurated clay.
8.5	55.6	23.1	Indurated clay (harder).

BORING NO. 31b.

0.0	63.6	25.6	Yellowish sand and mud.
6.8	56.8	23.5	Rock (ledge?).

TABLE 11.—*Shoals in Ouachita and Black rivers.*

Locality.	Distance.	Less than 1 meter deep.			Less than 2 meters deep.		
		Number.	Aggregate length.	Excavation for 15 meters width.	Number.	Aggregate length.	Excavation for 20 meters width.
	Kilometers.		*Kilometers.*	*Cubic meters.*		*Kilometers.*	*Cubic meters.*
Camden to Champagnolle	80.5	40	10.0	78,833	66	32.5	551,410
Champagnolle to Ouachita City	152.0	47	9.9	38,695	84	55.4	672,045
Ouachita City to Trinity	247.9	38	10.1	31,270	89	65.6	818,510
Trinity to mouth of Black River	90.6	0	0.0	0	1	0.5	6,500
Total	571.0	125	30.0	148,798	240	154.0	2,048,465

APPENDIX W.

IMPROVEMENT OF ARKANSAS RIVER AND OF CERTAIN RIVERS IN ARKANSAS AND MISSOURI.

REPORT OF CAPT. GRAHAM D. FITCH, CORPS OF ENGINEERS, OFFICER IN CHARGE FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Arkansas River, Arkansas.
2. White River, Arkansas.
3. Upper White River, Arkansas.
4. Buffalo Fork of White River, Arkansas.
5. Cache River, Arkansas.
6. Black River, Arkansas and Missouri.
7. Current River, Arkansas and Missouri.
8. St. Francis River, Arkansas.
9. St. Francis and L'Anguille rivers, Arkansas.
10. St. Francis River, Missouri.

ENGINEER OFFICE, UNITED STATES ARMY,
Little Rock, Ark., July 17, 1902.

GENERAL: I have the honor to forward herewith annual reports for the fiscal year 1902 of the following-named works of river and harbor improvements under my charge. * * *

Very respectfully, your obedient servant,

GRAHAM D. FITCH,
Captain, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

W 1.

IMPROVEMENT OF ARKANSAS RIVER, ARKANSAS.

Heretofore this improvement has been reported under two general heads, one entitled "Removing Obstructions in Arkansas River, Arkansas and Kansas," the other "Improving Arkansas River, Arkansas." These were consolidated by act of June 13, 1902, which in part is—

> Improving Arkansas River, Arkansas, including the general improvement and removing obstructions and operating snag boats: Continuing improvement and for maintenance, one hundred and ten thousand dollars: *Provided,* * * *

Operations this fiscal year.—The contract for repairing the snag boat *C. B. Reese,* in progress at the beginning of the year, was completed and the boat delivered at Memphis, Tenn., October 25, 1901.

There not being sufficient funds on hand to outfit and operate the boat, it has lain at Memphis since that date. Other operations were care of property and making a few discharge observations, the present appropriation not becoming available in time to do anything under it this year.

Gauges.—The gauges at Arkansas City, Kans., and at Tulsa, Ind. T., were discontinued September 30, 1901, and September 14, 1901, respectively.

Plant condemned.—Four barges 25 feet by 100 feet by 5 feet, one barge 20 feet by 60 feet by 3 feet, one quarter boat, and two scows were condemned during the year. This river is now entirely without floating plant for works of permanent improvement.

Discharge observations.—Low-water discharge observations were taken as opportunity offered. The principal ones are tabulated below. The gauges referred to are those nearest the point of observation. Double floats were used.

Discharge observations, Arkansas River, fiscal year 1902.

Locality.	Miles from mouth.	Date.	Gauge.	Water width.	Mean depth.	Area.	Average velocity.	Discharge.
		1901,	*Feet.*	*Feet.*	*Feet.*	*Square feet.*	*Feet per second.*	
In Grand River		Oct. 22	−1.2	122	2.5	304	1.109	337
Do		do	−1.2	122	2.5	306	1.055	323
Mean								330
Near mouth of Grand River	460.5	Oct. 22	(*a*)	514	4.2	2,176	1.072	*a* 2,332
Do		do		514	4.3	2,224	1.052	2,340
Mean								2,336
Fort Smith	368.5	Oct. 23	2.05	467	4.3	2,000	1.511	3,023
Do		do	2.05	467	4.4	2,030	1.416	2,875
Mean								2,949
Near Dardanelle	259.5	Oct. 24	.5	394	4.6	1,797	1.066	1,915
Do		do	.5	393	4.6	1,799	1.036	1,864
Mean								1,890
Meades Place	172.2	July 30	*b* 1.6	428	4.5	1,933	.945	1,827
Foot of Big Rock crossing	176.7	Sept. 5	*b* 1.5	530	4.4	2,355	.700	1,649
Do	176.7	Sept. 7	*b* 1.4	524	4.3	2,262	.686	1,551
Do		do	1.4	523	4.5	2,337	.683	1,595
Mean								1,573
Do	176.7	Oct. 7	*b* 1.3	511	4.2	2,155	.651	1,402
Do		do	1.3	511	4.2	2,153	.638	1,374
Mean								1,388
Do	176.7	Oct. 25	*b* 1.6	533	4.5	2,408	.853	2,052
Do		do	1.6	533	4.4	2,354	.871	2,052
Mean								2,052

[a] Said to be 1.25 to 1.5 feet higher than late in August and early in September, 1901.

[b] Little Rock Weather Bureau gauge. Lowest reading this year was 1.2 feet, October 8, 1901.

The balance available June 30, 1902, will be expended in operating snag boats and in applying $70,000 toward hydraulic dredge.

Estimates for future operations.—Unless the stages in the Arkansas River be considerably higher than they generally average through the autumn months, by June 30, 1903, the available balance will be reduced to such extent that all operations will be on a "care-of-property" basis, with funds barely sufficient to care for the property to July 1, 1904, and keep in reserve $70,000 to be applied to hydraulic dredge. On this supposition the amount required during fiscal year ending June 30, 1904, will be $100,000, detailed as follows:

Operate snag boat *Arkansas* 9 months	$15,000
Operate snag boat *C. B. Reese* 6 months	12,500
Procure and outfit dredge—additional funds required	60,000
Operate dredge 3 months	9,750
Apportionment of general office expenses	2,750
Total amount required for fiscal year ending June 30, 1904, in addition to amount unexpended June 30, 1902	100,00

Money statements.

REMOVING OBSTRUCTIONS IN ARKANSAS RIVER, ARKANSAS AND KANSAS.

July 1, 1901, balance unexpended	$8,071.59
June 30, 1902, amount expended during fiscal year	8,044.94
July 1, 1902, balance unexpended	26.65
July 1, 1902, outstanding liabilities	26.65

IMPROVING ARKANSAS RIVER, ARKANSAS.

July 1, 1901, balance unexpended		$8,526.00
Amount appropriated by river and harbor act approved June 13, 1902		110,000.00
		118,526.00
June 30, 1902, amount expended during fiscal year:		
General improvement	$1,035.62	
Removing obstructions	5,818.77	
		6,854.39
July 1, 1902, balance unexpended		111,671.61
July 1, 1902, outstanding liabilities		286.61
July 1, 1902, balance available		111,385.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902		100,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

July 3, 1832: For improving the navigation of the Arkansas River, Arkansas, Indian Territory, and Kansas (less $38 carried to surplus fund)	$14,962.00
March 3, 1835: For improving the navigation of the Arkansas River	40,000.00
March 3, 1837: For continuing the works	25,000.00
July 7, 1838: For the improvement of the Arkansas River (less $1,155.66 carried to the surplus fund)	38,884.34
From appropriations 1842–1844 (estimate)	80,000.00
August 30, 1852: For the improvement of the Arkansas River (less $269.47 carried to surplus fund)	39,730.53
From appropriations 1866–1878 (disbursements reported by Colonel Suter)	344,831.59
April 14, 1876: For removing the bar at Fort Smith, Ark	10,000.00

June 18, 1878: For removing the bar in the Arkansas River at Fort Smith	$10,000.00
March 3, 1879: For improvement of Arkansas River between Fort Smith, Ark., and Wichita, Kans	[a] 20,000.00
March 3, 1879: For removing snags, sand bars, wrecks, and other obstructions, and correcting and deepening the channel * * * on the Arkansas River	30,000.00
June 14, 1880: For improvement of Arkansas River between Fort Smith, Ark., and Wichita, Kans	[a] 15,000.00
June 14, 1880: For improving Arkansas River at Pine Bluff	25,000.00
June 14, 1880: For removing snags, wrecks, and other obstructions * * * on the Arkansas River	35,000.00
March 3, 1881: For improving Arkansas River between Fort Smith, Ark., and Wichita, Kans	[a] 24,000.00
March 3, 1881: For improving Arkansas River at Pine Bluff	23,000.00
March 3, 1881: For improving the Arkansas River	25,000.00
August 2, 1882: Continuing improvement between Fort Smith, Ark., and Wichita, Kans	[a] 20,000.00
August 2, 1882: Continuing improvement at Pine Bluff, Ark	20,000.00
August 2, 1882: Continuing removal of snags, wrecks, * * * from the Arkansas River	35,000.00
July 5, 1884:	
For survey of the Arkansas River from Little Rock to the mouth	[a] 19,000.00
Improving Arkansas River at Pine Bluff, Ark	55,500.00
For removing obstructions in Arkansas River from its mouth to Wichita, Kans	36,000.00
For the protection of the harbor at Fort Smith, Ark	5,000.00
August 5, 1886:	
Continuing improvement, according to plan and recommendation in Appendix V 13, Ex. Doc. 1, Forty-ninth Congress	75,000.00
For the removal of snags, wrecks, and other obstructions	19,875.00
August 11, 1888:	
Continuing improvement * * * between Wichita, Kans., and the navigable mouth of the Arkansas River	150,000.00
For removing obstructions	25,000.00
September 19, 1890:	
Continuing improvement from Wichita, Kans	180,000.00
For operating snag boats and removing obstructions	20,000.00
July 13, 1892:	
Improving Arkansas River, Arkansas and Indian Territory	250,000.00
Removing obstructions and operating snag boats	20,000.00
August 18, 1894:	
Continuing improvement ($10,000 may be used in removing obstructions and operating snag boats)	250,000.00
Removing obstructions and operating snag boats	20,000.00
June 3, 1896:	
Continuing improvement ($15,000 may be used in removing obstructions and operating snag boats)	100,000.00
Removing obstructions and operating snag boats	20,000.00
March 3, 1899:	
Continuing improvement ($50,000 may be used in removing snags, sand bars, and other obstructions)	100,000.00
Removing obstructions and operating snag boats	20,000.00
June 13, 1902: Continuing improvement and for maintenance, including the general improvement and removing obstructions and operating snag boats	110,000.00
Total appropriations	2,350,783.46
September 15, 1900: Allotted from emergency river and harbor act June 6, 1900, for repairs to Red Fork revetment	10,000.00
Total appropriations and allotments	2,360,783.46

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[a] Not included in former statements.

EXPENDITURES.

For removing obstructions and operating snag boats	$1,031,654.13	
For original construction of works for permanent improvement, including survey of river from Little Rock to the mouth	903,311.93	
For maintenance of works for permanent improvement	314,119.14	
Total expended to June 30, 1902		$2,249,085.20
Unexpended July 1, 1902		111,698.26
		2,360,783.46

CONTRACTS.

Name of contractor and work contracted for.	Rate.	Contract approved.	Work began.	Expiration of contract.
Ed J. Howard (repair snag boat)	$17,762.92	Aug. 13, 1900	Nov. 7, 1900	July 30, 1901

COMMERCIAL STATISTICS.

Excepting one single trip of the *Carrie Clyde* from the mouth of the river to the mouth of Grand River, there was no navigation reported above Shoal Creek, 88 miles below Fort Smith. The packet that formerly plied out of Fort Smith for points in Indian Territory did no business during the year. Navigation out of Little Rock was suspended from June 20, 1901, to December 14, 1901, excepting five days in August, and again from December 14, 1901, to February 20, 1902, excepting ten days late in January and early in February. It was suspended out of Pine Bluff from July 11, 1901, to August 8, 1901, and again from August 29, 1901, to December 16, 1901; and for a period of fifty-three days navigation was suspended over the entire river. The channel depths during the lowest water were about 20 inches to Silver Lake, and about 12 inches above that place.

List of vessels that navigated Arkansas River May 31, 1901, to June 1, 1902.

Name.	Tonnage.	Draft, loaded.		Between—	Round trips.	Passengers.
		Steamer.	Barge.			
		Ft. in.	*Ft. in.*			
Elva	53	6	3 0	Dardanelle and Shoal Creek	3	....
Myrtle Corey	10	2 0	2 6	Little Rock and Cadron	1	....
				Little Rock and Littles	3	....
				Little Rock and Ross Hollow	2	....
				Little Rock and Big Rock	87	....
Annie Tardy	57	3 0	4 0	Pine Bluff and Caldwells	6	520
Dardanelle	164	2 6	2 6	Little Rock and Pine Bluff	9	11
				Little Rock and Littles	4	32
				Little Rock and Fletchers	7	12
				Little Rock and Union City	4	....
				Little Rock and Stouts	2	....
				Little Rock and Bells Camp	1	....
				Little Rock and Eagle	1	1
				Pine Bluff and Browns	3	....
				Pine Bluff and Plum Bayou	1	5
				Excursions out of Little Rock	18	3,135
A. D. Allen	67	4 6	4 0	Little Rock and Pine Bluff	22	1,592
Chicago	33	1 8	....	Greenville and Foot of Cut-off	2	....
Edith	7	2 0	....	Rosedale and Red Fork	40	....
Carrie Clyde	60	3 0	....	Mouth to Coshka[a]	1	....
Lucille Nowland	298	5 0	....	Memphis and Pine Bluff	19	1,267
				Memphis and points below Pine Bluff.	3	
J. N Harbin	266	3 0	....	Memphis and Pine Bluff	15	953
				Memphis and points below Pine Bluff.	20	

[a] One way trip.

Classification of commerce reported.

Articles.	1902.
	Tons.
Cotton	4,240
Cotton seed	5,540
Hides and skins	57
Live stock	110
Lumber	862
Staves and bolts	4,445
Provisions	1,997
Grain	2,365
Saw logs	11,692
Piles	300
Miscellaneous freights	8,949
Total freights	40,557

Estimated value, $1,630,297.

APPENDIX TO ANNUAL REPORT OF IMPROVEMENT OF ARKANSAS RIVER, ARKANSAS.

With the passing of the attempt at the permanent improvement of the Arkansas River it seems fitting that there should be a brief review of the works erected for that purpose.

The first attempt at a general improvement of the river was made in 1884 by the construction of permeable 2-row pile dikes, designed to contract the river width at and below the 7-foot stage. These dikes when new caused the deposit of large quantities of sand, but as the brush screen in the upper row of piles soon became brittle and easily broken the dikes could not hold the deposits made. To remedy this defect they were filled with brush and stone, forming the type locally known as "solid pile" dikes. This type retained the foundation mattress used in the permeable dikes; transverse spacing of the piles was greater, and the brush and stone filling was brought up to about low water, above which to the top of the stringers stone alone was used. These dikes held well except that the filling settled badly, and in the course of a few years it was necessary to restore them to their original height, generally by a filling of stone only. The necessity of greater protection to the bank at the root of the dikes next became evident, a defect remedied by building a short revetment both above and below the dike. Then it became necessary to prevent the erosion of the opposite bank, which tended to recede until the original width was restored, thus neutralizing the effects previously gained by contraction. Further experience brought out the fact that merely holding the bends against erosion without further works in many cases improved the crossings below. As a standard revetment the type used in 1881 by Captain (now Lieutenant-Colonel) Ernst in the works near St. Louis, on the Mississippi River, was adopted with some minor modifications. These were, in the main, a wider spacing of the longitudinal poles (i. e., the weavers) and the abandonment of struts to hold the mattress to low-water line, the mattress being permitted to float close to the shore, regardless of the stage at which the weaving was done. If the stage was much above low water, the mattress was made wider to compensate for the portion that would be exposed when the river was at low stage, and that portion so exposed was covered solidly with riprap in the same manner as the graded bank. Partly on account of the scarcity of brush and partly because of the greater permanency of the resulting structure, a type of dike locally called the "stone dike" was finally adopted. In this no piles were used except such as were necessary for mooring working plant in position. The foundation, or that portion below low water, was made of alternate layers of standard mattress and stone. The shore protection consisted of about 150 linear feet of standard revetment (50 feet above and 100 feet below). This was built before the dike proper was begun. No attempt was made to control the flow when the river was above the 7 or 8 foot stage, and the plan finally fixed upon as the most efficient was to hold the bends by revetment and direct the current from the foot of the bends by means of low stone dikes. This gave considerable promise of a fair degree of success until the low water of 1897, with its corresponding small discharge of 1,170 cubic feet a second, showed that much more extensive work would be necessary to produce a navigable channel at all times. The flood of 1898 showed that the riprap in the standard revetment should be carried to flood level when possible. It also showed that the dikes should be designed to direct the flood flow as well as the extreme low-water flow.

While the works as built followed closely the plans of the adopted standards, in nearly every work some minor modifications were made to comply with the local conditions existing while the work was in progress. In the case of the mattresses for revetments, when the river was low and there was practically no current in the bends revetted, the anchor piles were omitted, as were some of the cables. When work was being carried on during higher stages and when drift was running, cables were much more freely used than shown in drawings. This change in the use of cables, which, by the way, were made on the works, caused the amount of wire used per square (100 square feet) of mattress to vary from 1.6 to 5.3 pounds, the average being about 2.5 pounds. The variation in the quantity of brush depended largely upon the kind used, the long, fine-limbed, straight brush wove closer and more was used to the square than of the shorter, scrubby kind of larger diameter. The quantities used varied from 0.420 cord per square of mattress to 0.652 cord per square, the average of 13 revetments being 0.520 cord per square. The stone used for sinking mattress ran quite uniformly one cubic yard of stone to one cord of brush.

The quantities of material used in the dikes varied greatly in different localities, due to differences in depths and to amount of scour while work was in progress.

Twenty-seven permeable pile dikes, aggregating 12,746 linear feet, varied in cost from $6.86 to $23.36 per linear foot, the average cost being $15.68. Solid pile dikes in about the same depth of water averaged about $26 per linear foot. Stone dikes in water of 2 to 5 feet depth at lowest stage cost $10.50 per linear foot. This was, however, under favorable circumstances, the location of the dikes being close to the source of stone supply. Stone dikes in water of 25 feet depth at low stage cost $76 per foot. The most expensive dikes built were in the Pine Bluff series, built for the protection of the town front of Pine Bluff. Here brush and stone dikes cost $81.60 per foot. The low-water depth was about 40 feet.

Revetment with the same width of mattress did not vary much in cost. Those built in the 20-mile reach above Little Rock cost from $3.28 to $4.16 per foot, the average cost of 26,513 feet being $3.93. Here the advantage of being near to stone supply had a great deal to do with the low cost of the work. The mattresses used in these revetments were generally 60 feet wide; only in one or two instances were 70-foot mattresses used, and then for a few days only. In the vicinity of Pine Bluff, revetments with mattress varying from 150 feet to 175 feet cost $11.31 per linear foot. Here the riprap was carried up the bank to 10-foot stage. Had it been carried to the 15-foot stage the cost would have been about $1.50 more per linear foot. At Red Fork, where the stone had to be towed from either Arkansas City (70 miles) or from De Valls Bluff (134 miles) the cost for revetment, with mattress 120 feet wide and riprap carried to about the 15-foot stage, was $14.52 per linear foot.

These costs include care of property during periods of no operations. The field costs during actual construction would be about 30 per cent less.

There is forwarded herewith one sheet showing the general construction of the standard types of dikes and revetment used.

W 2.

IMPROVEMENT OF WHITE RIVER, ARKANSAS.

Operations this fiscal year.—Repairs to the snag boat *C. B. Reese*, in progress at the beginning of the year under contract with Ed. J. Howard, Jeffersonville, Ind., were completed and the boat delivered at Memphis, Tenn., October 25, 1901. There not being sufficient funds to outfit the boat when it was delivered, it has been cared for at that place since that date. The present funds did not become available in time to do anything this fiscal year.

Estimates for future work.—The balance now available will be expended in outfitting, maintaining, and operating the snag boats *C. B. Reese* and *Beauregard*. By June 30, 1903, it will be reduced to such an extent that active field operations will be impracticable and there will be barely enough to care for the property to June 30, 1904.

Therefore, to carry on snagging operations during that year $18,000 should be provided. The estimate for this in detail is:

Operate snag boat *C. B. Reese*, 4 months	$8,250
Operate snag boat *Beauregard*, 4 months	6,500
Additions and renewal to machinery and appliances	2,750
Apportionment of general office expenses	500
Total required for fiscal year ending June 30, 1904, in addition to funds available June 30, 1902	18,000

The major portion of the outfit on the *C. B. Reese* and on the *Beauregard* is well worn and should be condemned as soon as funds for providing new are available. Lumbering industries along White River between the mouth of Little Red River and Newport have developed rapidly within the last year, and the stream is in need of more attention than heretofore contemplated.

Money statement.

July 1, 1901, balance unexpended	$12,217.69
Amount appropriated by river and harbor act approved June 13, 1902	22,000.00
	34,217.69
June 30, 1902, amount expended during fiscal year	11,305.39
July 1, 1902, balance unexpended	22,912.30
July 1, 1902, outstanding liabilities	209.22
July 1, 1902, balance available	22,703.08
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	18,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

APPROPRIATIONS.

Appropriations for this river have been partly for limited reaches, partly for the whole river, and partly for this river in combination with others.

The appropriations for this river separately and for reaches of it are as follows:

June 23, 1874	$50,000.00
August 14, 1876	10,000.00
March 3, 1879	10,000.00
June 14, 1880	20,000.00
June 14, 1880	5,000.00
March 3, 1881	8,000.00
August 2, 1882	6,000.00
August 2, 1882	4,000.00
July 5, 1884	35,000.00
August 5, 1886	18,000.00
August 11, 1888	25,000.00
September 19, 1890	$30,000.00
July 13, 1892	75,000.00
August 18, 1894	52,000.00
June 3, 1896	22,000.00
March 3, 1899	14,815.00
June 13, 1902	22,000.00
Total	406,815.00
Expended to June 30, 1902	383,902.70
Balance July 1, 1902	22,912.30

CONTRACT.

Name of contractor and work contracted for.	Rate.	Contract approved.	Work began.	Expiration of contract.
Ed J. Howard (repair snag boat)	$17,762.92	Aug. 13, 1900	Nov. 7, 1900	July 30, 1901

COMMERCIAL STATISTICS.

The river was navigable all the year from the mouth to Jacksonport. The maximum draft that could be taken over this portion of the river was about 2½ feet, the natural depths not being available on account of snags and logs. Between Jacksonport and Batesville navigation was suspended on account of low water from June 1, 1901, to February 24, 1902.

List of boats that navigated White River, Arkansas, between May 31, 1901, and June 1, 1902.

Name.	Net tons.	Draft, loaded.				Between.	Round trips.	Passengers.
		Steamers.		Barges.				
		Ft.	*in.*	*Ft.*	*in.*			
J. B. Galloway	36	2	2	5	0	Clarendon and Raleigh Reach Clarendon and St. Charles	72	....
Emma	5	3	0	3	0	De Valls Bluff and Peach Orchard	16	....
Liberty	353	5	0	....		Memphis and Clarendon	8	140
Grace Smith	66	3	6	4	0	Crocketts Bluff and Augusta	60	25
Kennedy	....	....		....		Newport and Batesville	1	....
Orlando	300	4	6	....		Memphis and Newport	[a] 5	180
Mary B	....	2	5	1	0	Mouth and Scrub Grass	1	6
Ozark Queen	136	3	0	2	0	Batesville and Newport	1	....
Harry Waltz	63	1	8	4	0	Newport and Black River points	35	16
						Newport and Oil Trough	2	0
						Newport and Orto Landing	6	28
Quickstep	66	2	6	4	0	Newport and Black River points	98	73
						Newport and McDougal	15	....
Evening Star	28	3	0	....		Pleasure boat	....	....
Mary F. Carter	50	2	6	2	6	....	....	....
A. R. Bragg	162	5	0	5	0	Newport and Current River	82	150
Krata	30	4	6	5	0	do	57	102
C. E. Taylor	50	3	6	5	0	do	20	50
F. W. Tucker	99	4	6	5	0	do	50	325
Jack Rabbit	32	1	8	....		Rosedale and Indian Bay	72	80
Chicago	....	1	8	....		Greenville and foot of cut-off	10	....
Monarch	43	3	6	4	6	Newport and Augusta	7	....
Edith	7	2	0	....		Rosedale and La Grue	40	....
Greyhound	9	5	6	....		Mouth to point 5 miles up	15	....
Gen. Joe Wheeler	65	2	6	3	0	Jacksonport and Grand Glaize	12	62
Current View	33	1	4	3	0	Jacksonport and Hugos Mill	16	31

[a] *Orlando* snagged and sunk July 6, 1901; total loss.

Classification of commerce reported.

Articles.	1902.
	Tons.
Cotton	1,144
Cotton seed	1,066
Lumber	6,387
Staves and bolts	8,421
Provisions	2,315
Grain	348
Square timber	1,750
Saw logs	88,717
Railroad ties	59,731
Cedar	3,500
Miscellaneous freights	7,687
Total freights	184,066

Estimated value, $1,242,438.

W 3.

IMPROVEMENT OF UPPER WHITE RIVER, ARKANSAS.

Operations this fiscal year.—At Lock No. 1 operations were confined to the care of property there and building foundations for marine ways.

At Lock No. 2 the timber extension to the abutment and the surrounding bank protection was practically completed, the lock walls built, and the space behind the land wall filled. The miter sills, valves, and ladders were placed and the balance of the lock irons purchased and stored at lock site. The telephone line from Gaynors Ferry to Lock No. 2, 5 miles, was finished. The river was at low stage all during excavation of lock pit and the construction of the lock walls, and the work progressed steadily from start to suspension, on November 30, 1901, when funds became practically exhausted. Two eight-hour shifts were employed nearly all the time and no work was done on Sundays. The following extract from report of Mr. William Parkin, assistant engineer, gives detail information regarding quantities of concrete used in the various parts of the lock walls:

* * * The first lock concrete was deposited in the foundation of the land wall on August 22, and the last was in the lower wing wall on November 16, 1901, a total of eighty-five days.

Including bowlders, the amount of concrete placed in the lock was 11,824 cubic yards, making an average of about 140 yards per day placed, not deducting lost time or Sundays. Five hundred and forty-nine cubic yards of the concrete placed in the lock was made up of bowlders, ranging in size from 1 to 50 cubic feet, which were mostly secured from the lock-pit excavation. Each stone was placed separately, and plenty of tamping room left behind them. The following table shows the amounts of concrete placed in the various parts of the lock:

Summary of concrete in Lock No. 2, November 30, 1901.

	Foundation, concrete.	Foundation, bowlders.	Above foundation, concrete.	Above foundation, bowlders.	Total concrete.	Total bowlders.
	Cubic yds.	*Cubic yds.*	*Cubic yds.*	*Cubic yds.*	*Cubic yds.*	*Cubic yds.*
Upper miter wall	230	25	234	....	464	25
Lower miter wall	237	....	8	....	245	....
Breast wall	....	....	77	10	77	10
Upper wing wall	....	....	177	27	177	27
Lower wing wall	....	....	307	145	307	145
River wall	2,073	103	3,275	115	5,351	218
Land wall	1,820	114	3,383	10	5,208	124
Total	4,360	242	7,464	307	11,824	549

	Cubic yards.
Total concrete in lock	11,824
Of which bowlders constitute	549
Leaving (mixed concrete)	11,275

The method of mixing and placing concrete was the same as reported in the last annual report for Lock No. 1, except that the concrete was deposited in horizontal layers instead of being built up in vertical sections.

Work was finally suspended on November 30, 1901, on account of exhaustion of funds, and since that date the small crew retained to care for property have been busy pulling nails and repiling lock-form lumber, repairing the machinery, tools, etc., making cement tests, and taking discharge observations.

* * * * * * *

During the period of no active operations the small force retained at the lock, primarily to care for the works and the property, made a few discharge observations and also continued cement tests with a view to determine the relative economy in the use of the fine White River sand as compared with coarser sand obtained from the Arkansas River. As this series of tests is not yet completed, exhibit of the various results obtained is withheld for future report. The results of the discharge observations are tabulated below.

Discharge observations, Upper White River, Arkansas.

[Observations taken at Maxwell's Gin, 2 miles below Lock No. 2. Mid depth floats were used.]

Date.	Lock 2, lower miter sill gauge.	Elevation of water.		Mean water width.	Mean depth.	Area.	Average velocity.	Discharge.
		Start of observation.	Close of observation.					
1902.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet per second.*	*Cu. ft. per second.*
April 11	7.5	248.6	248.6	390	10	3,915	2.008	7,861
April 19	7.9	249	249	395	10.4	4,120	2.349	9,677
May 7	6.5	247.6	247.6	380	9.4	3,560	1.741	6,198
May 17	10.6	251.7	251.7	432	11.8	5,100	3.546	18,082
May 21	10.1	251.2	251.2	425	10.9	4,652	3.193	14,856
May 28	9	250.1	250.2	410	10.1	4,390	2.985	13,077
June 14	4.9	246	246	345	8.3	2,866	1.055	3,033

It is proposed to expend the available funds in completing and putting in operation Locks No. 1 and No. 2, and possibly in building the lock walls and abutment at Lock No. 3.

Estimates for future operations.—The scheme of work is to complete dam at Lock No. 1 and build pile foundation and a portion of dam at Lock No. 2 this fall; also commence the construction of lock walls at Lock No. 3 as soon as possible after receipt of authority to begin work. Following out this plan, it is thought the dam at Lock No. 2 and the concrete work at Lock No. 3 will be completed in the fall of 1903, making it possible to proceed with the construction of the dam at Lock No. 3 and the lock walls at Lock No. 4, funds for which, however, are not available. Therefore, to continue the work without interruption, $168,500 will be needed during the fiscal year ending June 30, 1904, the estimate for which, in detail, is:

At Lock No. 3:	
Build gates	$4,750
Build levee behind abutment	510
Build lock house, outhouses, etc	3,300
Procure material for dam and cribs and begin construction of dam	40,000
	48,560
Apply to construction of Lock No. 4	110,000
Build new hull for dredge and transfer machinery, etc	6,000
Apportionment of general office expenses	3,940
Amount required during fiscal year ending June 30, 1904, in addition to the amount unexpended June 30, 1902	168,500

* * * * * * *

Money statement.

July 1, 1901, balance unexpended		$94,501.37
Amount appropriated by river and harbor act approved June 13, 1902		270,000.00
		364,501.37
June 30, 1902, amount expended during fiscal year:		
Lock No. 1	$7,618.95	
Lock No. 2	77,701.27	
		85,320.22
July 1, 1902, balance unexpended		279,181.15
July 1, 1902, outstanding liabilities		1,845.84
July 1, 1902, balance available		277,335.31
Amount (estimated) required for completion of existing project		1,020,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902		168,500.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

APPROPRIATIONS.

March 3, 1899	$160,000.00
June 6, 1900	150,000.00
June 13, 1902	270,000.00
Total	580,000.00
Expended to June 30, 1902	300,818.85
Unexpended July 1, 1902	279,181.15

CONTRACTS.

Name of contractor and article contracted for.	Rate.	Contract approved.	Work began.	Expiration of contract.
Glencoe Lime and Cement Co.:				
11,000 barrels cement	1.82	Mar. 29, 1901	Apr. 3, 1901	July 22, 1901
Griffiths Iron Works Co.:				
14,693 pounds wrought iron	.049	May 31, 1901	June 5, 1901	July 20, 1901
13,752 pounds cast iron	.039			
7,200 pounds steel	.0675			

COMMERCIAL STATISTICS.

No lock being in operation, navigation was controlled by the conditions existing in the open river, which were such that steamboat navigation was impracticable because of shoal water from June 1, 1901, to February 24, 1902. The disastrous drought, which began in April, 1901, and continued until February, 1902, brought financial ruin to many, and placed whole communities under the care of the charitable public, and had a considerable effect on the volume of commerce.

List of boats that navigated Upper White River, Arkansas, from May 31, 1901, to June 1, 1902.

Name.	Net tons.	Draft loaded.		Between—	Round trips.	Passengers.
		Steamers.	Barges.			
		Ft. in.	*Ft. in.*			
Kenneday	126	3 0	3 0	Batesville and White Hall	7	180
				Penters Bluff and White Hall	4	270
Ozark Queen	136	3 0	2 0	Batesville and Oakland	1	1,062
				Batesville and McBee Landing	1	
				Batesville and Buffalo	7	
				Batesville and Sneed Creek	7	
Buck Elk	58	2 6	1 2	Penters Bluff and Buffalo City	13	195
Eureka	57	1 6	....	Batesville and Calico Rock	3	45

Classification of commerce reported.

Articles.	1902.
	Tons.
Cotton	220
Cotton seed	....
Lumber	520
Staves	190
Provisions	1,249
Grain	890
Cedar	9,800
Railroad ties	13,115
Miscellaneous	1,488
Total freights	27,472
Estimated value	$758,040

W 4.

IMPROVEMENT OF BUFFALO FORK OF WHITE RIVER, ARKANSAS.

Nothing done during the year. The small balance available at the beginning of the year was practically all expended caring for property. There was no commerce on the stream during the year. No further work is recommended.

Money statement.

July 1, 1901, balance unexpended	$448.44
June 30, 1902, amount expended during fiscal year	343.44
July 1, 1902, balance unexpended	105.00
July 1, 1902, outstanding liabilities	50.25
July 1, 1902, balance available	54.75

APPROPRIATIONS.

The only appropriation was that of March 3, 1899, $3,500; expended to June 30, 1902, $3,395; unexpended July 1, 1902, $105.

COMMERCIAL STATISTICS.

Year ending May 31, 1902, no commerce; year ending May 31, 1901, 718 tons of rafted railway ties, estimated value $1,940; year ending May 31, 1900, 998 tons of rafted cedar and railway ties, estimated value $8,436.

W 5.

IMPROVEMENT OF CACHE RIVER, ARKANSAS

Operations this fiscal year.—Nothing done.

Estimate for future operations.—To maintain a channel reasonably free from snags from the mouth of the river to James Ferry $2,000 is required annually. The funds now available will be expended in snagging operations carried on by means of a chopping party. The work will be begun in the vicinity of James Ferry and carried as far downstream as the funds will permit.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902 ..	$2,000.00
July 1, 1902, balance unexpended	2,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to balance unexpended July 1, 1902 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	2,000.00

APPROPRIATIONS AND ALLOTMENTS.

August 11, 1888, mouth to Riverside	$7,000.00
July 13, 1892, mouth to Riverside	2,000.00
August 17, 1894, allotted from White River	2,000.00
June 3, 1896, allotted from White River	2,000.00
March 3, 1899, mouth to James Ferry	1,000.00
June 13, 1902, mouth to James Ferry	2,000.00
Total	16,000.00
Expended to June 30, 1902	14,000.00
Unexpended July 1, 1902	2,000.00

COMMERCIAL STATISTICS.

The river was too low for navigation from May 1, 1901, to January, 1902.

List of vessels that navigated Cache River, Arkansas, from May 31, 1901, to June 1, 1902.

Name.	Net tons.	Draft loaded. Steamers.	Draft loaded. Barges.	Between.	Round trips.	Passengers.
		Ft. in.	*Ft. in.*			
Emma	5	3 0	3 0	Choctaw Bridge and Yorks Landing.	11	....
Grace Smith	66	3 6	2 0	Clarendon and log camps	10	....
Geo. W. Maberry	16	2 0	....	Maberry and Choctaw Bridge	6	1

Classification of commerce reported, 1902.

	Tons.
Staves and bolts	2,350
Saw logs	11,005
Railroad ties	2,280
Miscellaneous freights	41
Total freights	15,676
Estimated value	$40,301

W 6.

IMPROVEMENT OF BLACK RIVER, ARKANSAS AND MISSOURI.

Operations during this fiscal year.—Nothing done. The small balance ($218.81) available July 1, 1901, was expended in caring for the hand-propelled snag boat *Riverside*. The appropriation of June 13, 1902, did not become available in time to do anything under it this year.

Estimates for future works.—Many complaints are received regarding the condition of this river. The estimate of $8,000 annually, adopted in 1884, is not sufficient to meet the demands of the commercial interests. To properly snag the river and maintain the channels so obtained $12,000 is required for working expenses each year. To this should be added at least $3,000 for care of the boats during periods of high water and for annual repair, making $15,000 as the amount required annually. The stream is believed to be worthy of this.

The balance now available will be expended in maintaining and operating snag boats over the river from its mouth to Poplar Bluff, Mo. It is thought that by June 30, 1903, there will be only sufficient funds remaining to care for the property during the fiscal year ending June 30, 1904; therefore, to provide for snagging operations during that year, $12,000 is required in addition to the amount now available. The estimate in detail is:

Operate snag boat *Beauregard* below mouth of Current River, 4 months	$6,500
Operate snag boat *Riverside* above mouth of Current River, 7 months	5,250
Apportionment of general office expenses	250
Amount required for fiscal year ending June 30, 1904, in addition to amount unexpended June 30, 1902	12,000

Money statement.

July 1, 1901, balance unexpended	$263.81
Amount appropriated by river and harbor act approved June 13, 1902	21,700.00
	21,963.81
June 30, 1902, amount expended during fiscal year	257.27
July 1, 1902, balance unexpended	21,706.54
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	12,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

APPROPRIATIONS.

Appropriations have been made for this stream separately under the heads of "Improving Black River, Missouri," "Improving Black River, Arkansas," and "Improving Black River, Arkansas and Missouri." They are as follows:

June 14, 1880	$15,000.00	August 18, 1894	$9,500.00
March 3, 1881	6,000.00	June 3, 1896	8,000.00
August 2, 1882	10,000.00	March 3, 1899	8,000.00
July 5, 1884	20,000.00	June 13, 1902	21,700.00
August 5, 1886	5,000.00		
August 11, 1888	5,000.00	Total	132,200.00
August 11, 1888	7,000.00	Expended to June 30, 1902	110,493.46
September 19, 1890	5,000.00		
September 19, 1890	7,000.00	Unexpended July 1, 1902	21,706.54
July 13, 1892	5,000.00		

COMMERCIAL STATISTICS.

Boats of not over 18 inches draft could navigate all the year to Poplar Bluff, Mo. Boats of 30 inches draft could navigate all the year to the mouth of Current River. During period of lowest water, towboats and rafts were laid up.

List of vessels that navigated Black River, Arkansas and Missouri, from May 31, 1901, to June 1, 1902.

Name.	Net tons.	Draft loaded.				Between—	Round trips.	Passengers.
		Steamer.		Barges.				
		Ft.	*In.*	*Ft.*	*In.*			
El Blanco	32	2	6	4	0	Corning and Poplar Bluff	84	60
Roy	24	2	2	3	0	....do	115	200
Alma Jane	24	2	0	2	6	Poplar Bluff and State line	42	....
Harry Waltz	63	1	8	4	0	Newport and Black Rock	35	16
Quickstep	66	2	6	5	0	....do	98	73
Arthur	22	1	2	(?)		Pleasure boat	7	(?)
A. R. Bragg	162	5	0	5	0	Newport and Current River	82	150
Krata	30	4	6	5	0	....do	57	102
C. E. Taylor	50	3	6	5	0	....do	20	50
F. W. Tucker	99	4	6	5	0	....do	50	325
Gen. Joe Wheeler	65	2	6	3	0	Newport and Black Rock	64	256
Current View	33	1	4	3	0	Newport and mouth of Strawberry River.	40	120

Classification of commerce reported, 1902.

	Tons.
Cotton	688
Cotton seed	948
Lumber	17,277
Staves and bolts	12,053
Provisions	1,542
Grain	496
Spokes	1,590
Saw logs	54,245
Railroad ties	72,133
Piling	3,680
Square timber	910
Miscellaneous freights	651
Total freights	166,213
Estimated value	$919,767

W 7.

IMPROVEMENT OF CURRENT RIVER IN ARKANSAS AND MISSOURI.

Operations this fiscal year.—Nothing done. The small balance ($299) available July 1, 1901, was expended in caring for the snag boat *Riverside*. The appropriation of June 13, 1902, did not become available in time to do anything this year.

Estimates for future works.—Twenty-four days of actual snagging is all that has been applied to this river within the last two years. The funds now available will be expended in maintaining and operating snag boats—the steam-propelled boat to work from the mouth up to the mouth of Little Black River, and the hand-propelled boat to work from the mouth of Little Black up as far as funds will permit. It is doubtful if the benefits obtained in fiscal year 1900 will be reobtained with the present funds. Probably by June 30, 1903, operations will have to cease because of exhaustion of funds. To continue the work during the fiscal year ending June 30, 1904, $5,625 will be required. This estimate in detail is:

Operate snag boat *Beauregard* two months	$3,250
Operate snag boat *Riverside*, three months	2,250
Apportionment of general office expenses	125
Amount required during fiscal year ending June 30, 1904, in addition to funds unexpended June 30, 1902	5,625

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$315.91
Amount appropriated by river and harbor act approved June 13, 1902	6,900.00
	7,215.91
June 30, 1902, amount expended during fiscal year	302.94
July 1, 1902, balance unexpended	6,912.97
July 1, 1902, outstanding liabilities	12.97
July 1, 1902, balance available	6,900.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	5,625.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

APPROPRIATIONS.

The early examinations of this river were made under appropriations for this in combination with other streams. The independent appropriations for this stream are as follows:

June 2, 1872, Current River, Missouri	$5,000.00
March 3, 1881, Current River, Arkansas and Missouri	2,000.00
August 18, 1894, Current River, Arkansas and Missouri	8,000.00
June 3, 1896, Current River, Arkansas and Missouri	2,000.00
March 3, 1899, Current River, Arkansas and Missouri	5,000.00
June 13, 1902, Current River, Arkansas and Missouri	6,900.00
Total	28,900.00
Expended to June 30, 1902	21,987.03
Unexpended July 1, 1902	6,912.97

COMMERCIAL STATISTICS.

No steamboat reports going above Johnsons Landing, 25 miles above the mouth. Very small gasoline boats, from which no reports could be obtained, operated out of Doniphan, Mo. Saw logs and railway ties were rafted from all along the stream.

List of boats that navigated Current River, Arkansas and Missouri, from May 31, 1901, to June 1, 1902.

Name.	Net tons.	Draft loaded.		Between—	Round trips.	Passengers.
		Steamer.	Barges.			
		Ft. in.	*Ft. in.*			
A. R. Bragg	162	5 0	5 0	Newport and Johnsons Landing.	82	150
Krata	30	4 6	5 0	do	57	102
C. E. Taylor	50	3 6	5 0	do	20	50
F. W. Tucker	99	4 6	5 0	do	50	325

Classification of commerce reported, 1902.

	Tons.
Cotton	225
Cotton seed	325
Lumber	275
Staves and bolts	563
Provisions	170
Saw logs	12,456
Railroad ties	23,371
Square timber	750
Miscellaneous freights	50
Total freights	37,185
Estimated value	$165,766

W 8.

IMPROVEMENT OF ST. FRANCIS RIVER, ARKANSAS.

Operations during the year.—Nothing done. Most of the small balance ($205.61) available July 1, 1901, was expended in care of the snag boat *A. B. Johnson.*

Congress, by act approved June 13, 1902, consolidated the improvement of this river with that of L'Anguille River under the appropriation title "Improving St. Francis and L'Anguille rivers, Arkansas." Under this new title recommendations as to future operations are made.

Money statement.

July 1, 1901, balance unexpended	$256.19
June 30, 1902, amount expended during fiscal year	251.04
July 1, 1902, balance unexpended	5.15
July 1, 1902, outstanding liabilities	2.67
July 1, 1902, balance available	2.48

APPROPRIATIONS.

The earlier examinations and the earlier operations were made under appropriations for this in conjunction with other rivers. Of the expenditures under these appropriations this office has no record.

The separate appropriations are as follows:

March 3, 1871	$10,000.00
June 14, 1880	5,000.00
July 5, 1884	12,000.00
August 5, 1886	8,000.00
August 11, 1888	4,000.00
September 19, 1890	4,000.00
August 18, 1894	[a]83,000.00
June 3, 1896	8,000.00
March 3, 1899	8,000.00
Total	142,000.00
Expended to June 30, 1902, for regular project	66,994.85
Unexpended July 1, 1902	5.15

COMMERCIAL STATISTICS.

Above Black Fish Cut-off the river was too low for navigation from July 10, 1901, to January 8, 1902. Below Black Fish Cut-off it was too low from August 15, 1901, to December 15, 1901.

List of boats that navigated St. Francis River, Arkansas, from May 31, 1901, to June 1, 1902.

Name.	Net tons.	Draft, loaded.		Between—	Round trips.	Passengers.
		Steamer.	Barges.			
		Ft. In.	*Ft. In.*			
Rock City	53	2 0	5 0	Helena and points on lower St. Francis.	100	
Welcome	28	4 0		Towing to marked tree		
Helena	9	2 6	2 0	Helena and Ashworths	52	200
J. B. Butts	12	2 6		do	52	
Grace Velie	53	3 0		Helena and Cut-off	(a)	
G. M. Sivley	98	3 6	5 6	Short Bend and Helena	(a)	
L. E. Patton	92	4 6	6 0	Mouth and Big Eddy	26	
J. C. Atlee	87	3 6	6 0	do	2	

a Not reported.

Classification of commerce reported, 1902.

	Tons.
Cotton	175
Cotton seed	1,230
Hides	1
Live stock	100
Lumber	2,035
Provisions	220
Grain	380
Saw logs	81,588
Miscellaneous freights	102
Total freights	85,831
Estimated value	$269,190

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[a] $75,000 of this, by conditions of the act, were to be expended by the Mississippi River Commission for levee construction.

W 9.

IMPROVEMENT OF ST. FRANCIS AND L'ANGUILLE RIVERS, ARKANSAS.

This is a new appropriation title adopted by act of Congress approved June 13, 1902. It revives a former work known by the title "Improving L'Anguille River," and consolidates it with that of "Improving St. Francis River, Arkansas." Nothing was done under it this year, as the appropriation became available too late in the year.

Remarks and estimates for future operations.—Neither of the streams covered by this appropriation is navigable during lowest stages. The navigable stages depend largely upon the stages of the Mississippi River, of which the St. Francis is a tributary. The operations for improvement are mainly snagging operations, and the greatest number of obstructions, sunken saw logs, are made by the users of the streams. Rafting is the principal commerce, and the saw logs of the heavier woods, locally known as "sinkers," lost from the rafts, settle directly to the bottom of the channel. It is of frequent occurrence that a snag boat during a week's work will raise no other obstructions than these "sinkers." They are most troublesome to navigation when the rivers are just above low stage and barely navigable. At higher stages, since they lie flat on the bottom, they do not interfere. This condition makes it necessary to carry on the snagging operations at the very period when it is most difficult for the snag boat to get from one pool to another, and frequently a slight lowering of the stage in the river causes suspension of operations for this reason alone. These remarks apply to the St. Francis River below the Sunk Land and the L'Anguille below Marianna. In the Sunk Land snagging operations are possible only when the river is at high stages. During low-water period its bed is dry in many places, and since there is practically no navigation on this portion of the river, it can, without detriment, be omitted from estimates for future work. In 1884 the estimate for snagging operations on the St. Francis River was made $8,000 annually. Working under this, the scheme of operations has been to work below Madison one season and above Madison the next. This plan has not been followed strictly, as it has not been possible to keep the lower river reasonably free of obstructions with a biennial appropriation of $8,000. Although no work has been done between Ash Bend (110 miles above the mouth) and Marked Tree (177 miles above the mouth) since fiscal year 1894, the funds now available will be expended in snagging operations below Madison, on the St. Francis River, and below Marianna, on the L'Anguille River. It is thought that by June 30, 1903, there will not be sufficient funds available to operate a snag boat that fall; therefore $8,000 will be required during the fiscal year ending June 30, 1904. If such be provided it will probably be expended in much needed snagging operations above Madison.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902...	$9,000.00
July 1, 1902, balance unexpended	9,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902..	8,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

Total appropriated for St. Francis River, Arkansas (shown in detail under "Improving St. Francis River, Arkansas")	[a]$142,000
June 18, 1878, L'Anguille River	10,000
March 3, 1879, L'Anguille River	5,000
June 14, 1880, L'Anguille River	2,000
June 13, 1902, St. Francis and L'Anguille rivers, Arkansas	9,000
Total for St. Francis and L'Anguille rivers, Arkansas	168,000

COMMERCIAL STATISTICS.

Neither stream was navigable all the year. The navigation periods are governed largely by the stages of the Mississippi River. No statistics were gathered for these rivers this year; however, as a close estimate, the commerce is 96,700 tons, having an estimated value of $291,000. It is mainly that arising from lumber industries.

W 10.

IMPROVEMENT OF ST. FRANCIS RIVER, MISSOURI.

This is a revival of an old work with this exception: In the former work the improvement was to extend from Kennett, Mo., to Greenville, Mo. (128 miles), while in this it is to extend from the head of the Sunk Lands to Poplin, Mo. (84 miles).

Operations this fiscal year.—Nothing done, the funds appropriated by act of June 13, 1902, not becoming available in time.

At the present time recommendation either for or against this work can not be made, as opportunity to investigate existing conditions has not occurred. There are no steamboats on the river at the present time and rafting appears to have dwindled away to nearly nothing.

The present funds will be expended in procuring necessary plant and in snagging the river from Poplin as far downstream as the funds will permit. It is thought that the proposed work will satisfy the needs of commerce until the close of the fiscal year ending June 30, 1904, and no recommendation regarding funds for that year is made.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902	$10,000.00
July 1, 1902, balance unexpended	10,000.00

APPROPRIATIONS.

This reach of river is understood not to have been included in the snagging operations under the early appropriations for snagging in Western rivers. Its specific appropriations are as follows:

August 11, 1888	$5,000.00
September 19, 1890	10,500.00
August 18, 1894	5,000.00
June 13, 1902	10,000.00
Total	30,500.00
Expended to June 30, 1902	$20,500.00
Unexpended July 1, 1902	10,000.00

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[a] Seventy-five thousand dollars of appropriation of August 18, 1894, was expended by the Mississippi River Commission for levee construction.

COMMERCIAL STATISTICS.

The steamer *Ike*, the last of the steamers on this river, left it this year without doing any business on the river. The river was too low for navigation from June 17, 1901, to March 7, 1902.

Classification of commerce reported 1902.

	Tons.
Saw logs	6,000
Railroad ties	420
Total freights	6,420
Estimated value	$13,092

APPENDIX X.

REMOVING SNAGS AND WRECKS FROM MISSISSIPPI RIVER; IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN THE OHIO AND MISSOURI RIVERS, OF HARBOR AT ST. LOUIS, MISSOURI, AND IMPROVEMENT TO PREVENT THE MISSISSIPPI FROM BREAKING INTO CACHE RIVER AT BEECHRIDGE, ABOVE CAIRO, ILL.

REPORT OF MAJ. THOS. L. CASEY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Removing snags and wrecks from the Mississippi River below the mouth of the Missouri River.
2. Mississippi River between Ohio and Missouri rivers.
3. Harbor at St. Louis, Mo.
4. To prevent the Mississippi River from breaking through into the Cache River at or near a point known as Beechridge, above Cairo, Ill.

ENGINEER OFFICE, UNITED STATES ARMY,
St. Louis, Mo., July 11, 1902.

GENERAL: I have the honor to transmit herewith the annual report for the works under my charge for the fiscal year ending June 30, 1902.

Very respectfully, your obedient servant,

THOS. L. CASEY,
Major, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

X 1.

REMOVING SNAGS AND WRECKS FROM THE MISSISSIPPI RIVER BELOW THE MOUTH OF THE MISSOURI RIVER.

A concise statement of the project for and history of this work will be found in the Annual Report of the Chief of Engineers, United States Army, to which this report is an appendix, as well as on page 2621 of the Report of the Chief of Engineers, United States Army, for 1900.

This work is now being done through the instrumentality of two large steel-hulled snag boats, *H. G. Wright* and *J. N. Macomb*, fitted with all necessary tools and appliances and operated by hired men; they patrol the river between the mouth of the Missouri River and Natchez, Miss., with an occasional visit as far down as New Orleans, La.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1902.

At the beginning of the fiscal year the snag boat *J. N. Macomb*, was laid up in ordinary at St. Louis, Mo., undergoing repairs. On July 11, the river having fallen to a stage favorable for successful work, the boat, under command of Capt. Alex. H. Stewart, left St. Louis and proceeded to patrol the river between Memphis, Tenn., and Natchez., Miss. This boat was constantly at work until March 31, 1902, when it was laid up at St. Louis on account of high water. Since that time the boat has been undergoing minor repairs.

At the beginning of the fiscal year the snag boat *H. G. Wright* was laid up at St. Louis, Mo., undergoing minor repairs. The condition of the river being favorable for work, this boat was put in service on August 1, under command of Capt. James Taylor, to begin the patrol of the river between the mouth of the Missouri River and Memphis, Tenn. The boat was constantly at work until March 20, 1902, when it was laid up at St. Louis on account of high water, and since that time has been undergoing minor repairs.

The repairs that have been made to the boats have put them in good condition to resume work as soon as the stage of the river is favorable.

It having become evident that it would be proper economy to install on each of the snag boats an ice-making and refrigerating plant, on January 29, 1902, authority to establish two suitable plants at an estimated cost of $7,400 was requested of the Chief of Engineers. This was granted on February 4, 1902. Specifications for the portion which was to be procured by contract were prepared and after due advertisement the bids received were opened April 14, 1902. The lowest satisfactory bid being in excess of the portion of the original estimate allowed to these items, the authority of the Chief of Engineers was requested to increase the limit of cost to $9,400, which was granted April 25, 1902. Contract was entered into May 10 with the lowest bidder, the New Jersey Foundry and Machine Company of New York, in the sum of $7,100 for the two plants.

The capacity of these plants assures an abundance of ice and refrigeration and it is unquestioned that such a saving will be effected both in ice consumed and wastage in subsistence stores that from a commercial point of view the plants will prove a judicious investment.

A summary of the work accomplished by the two boats during the fiscal year is found in the following table:

Name.	Snags pulled.	Trees cut.	Drift piles removed.	Miles run.
John N. Macomb	2,206	15,548	8	11,248
Horatio G. Wright	1,701	13,322	19	6.609
Total	3,970	28,870	27	17,857

In addition to the above, the snag boats removed or destroyed wrecks as follows:

J. N. Macomb.—September 30, 1901, wreck of coal barge opposite Sunnyside Landing, Ark.; March 29, 1902, wreck of barge at foot of Dorcas street, St. Louis, Mo.

H. G. Wright.—October 5, and November 6, 7, and 8, 1901, wrecks of steamers *Rock Island* and *Stephen Beard* in St. Louis Harbor; November 9, 11, and 12, 1901, wreck of steamer *Memphis*, foot of George street, St. Louis, Mo.; March 7-10, 1902, wreck of cement barge 50 miles below St. Louis, Mo.; May 10, 1902, wreck of steamer *Lulu Worth*, St. Louis Harbor.

The trees referred to are generally leaning timber in bends of the river, or trees that are liable to fall into the water and become obstructions to navigation.

An annual appropriation of an amount not to exceed $100,000 having been made for this work, the snag boats will patrol the river whenever necessary, in order to keep the channel free from obtructions, such as snags, logs, drift piles, leaning trees, and such wrecks as they may be able with their appliances to remove after the same have been blown to pieces with explosives.

EXPENDITURES.

The amount expended on this work to July 1, 1901, under all specific appropriations since and to include March, 1879, is $1,633,834.59.

Amount expended from current allotment during the fiscal year, $92,639.67. A detailed statement of this expenditure, as required by law, is given in the accompanying Tables 1 and 2.

The work was all done by hired labor. In general, the material has been purchased from the lowest bidder for the most suitable article, after ten days' advertisement for proposals. In many cases this method was impracticable. Purchases were then made in open market in the manner usually pursued by private individuals. The work done by the snag boats is of great benefit to the commerce and navigation on the river. Before the work was so completely patrolled as it now is, the sinking of steamboats and other river craft by running on snags was a common occurrence. During recent years such disasters seldom happen. Although life and property would seem to be much safer now than formerly, the rate of insurance has not materially decreased.

It is proposed during the coming fiscal year to continue operating these snag boats, as provided for in the river and harbor act of August 11, 1888.

The statistics relating to the commerce benefited by the operations of these snag boats will be found in the report of operations for this year for the improvement of the Mississippi River from the mouth of the Missouri to the mouth of the Ohio River.

The headquarters of the snag boats is in St. Louis.

The amount of internal revenue collected was $13,009,406.81.

Money statement.

Amount drawn under section 7, act of August 11, 1888	$92,639.67
June 30, 1902, amount expended during fiscal year	92,639.67
July 1, 1902, amount available for fiscal year 1902-3	100,000.00

APPROPRIATIONS MADE BY CONGRESS FOR REMOVING OBSTRUCTIONS IN MISSISSIPPI RIVER.

By act of—	
March 3, 1879	$100,000.00
June 14, 1880	100,000.00
March 3, 1881	80,000.00
March 2, 1882	85,000.00
July 5, 1884	72,950.63
August 5, 1886	56,250.00
August 11, 1888	100,000.00
Fiscal year ending June 30—	
1890	49,089.17
1891	92,720.97
1892	98,250.00
1893	$96,497.23
1894	88,252.46
1895	100,000.00
1896	80,496.26
1897	83,421.64
1898	88,917.74
1899	88,923.15
1900	86,355.29
1901	86,710.05
1902	92,639.67
Total	1,726,474.26

CONTRACT IN FORCE.

Articles: Two refrigerating plants.

Rate: $3,550 each.

Name of contractor: New Jersey Foundry and Machine Company, of New York, N. Y.

Date of approval: May 26, 1902.

Date of beginning work: On approval of bid.

Date of expiration: June 6, 1902. (Extended to July 5, 1902.)

TABLE NO. 2.—*Summary of expenses for operating U. S. snag boats H. G. Wright and J. N. Macomb in connection with the work of removing obstructions in Mississippi River during the fiscal year ending June 30, 1902.*

Application.	1901.					
	July.	August.	September.	October.	November.	December.
Office expenses	$1,003.35	$2.00	$1,067.00	$33.54	$6.30	$18.83
Expenses of snag boat H. G. Wright:						
Crew	1,431.50	2,143.84	335.00	3,941.00	2,157.00	2,135.00
Outfit				40.00		
Fuel	8.50	493.40	473.50	1,065.50	491.13	1,184.45
Subsistence	269.40	519.64	620.38	760.91	610.64	390.77
Supplies				4.50	265.14	
Repairs	129.96		55.90	.75	7.10	1.50
Miscellaneous						
Expenses of snag boat J. N. Macomb:						
Crew	1,952.83	2,134.33	2,123.01	2,110.50	2,116.50	2,139.00
Outfit						
Fuel	425.70	540.00	2,078.75	735.00	1,193.13	1,395.00
Subsistence	808.46	420.98	455.83	663.27	290.06	301.96
Supplies					20.50	
Repairs						
Miscellaneous	13.25			10.90		
Total	6,042.95	6,254.19	7.209.37	9,365.87	7,157.50	7,566.51

TABLE No. 2.—*Summary of expenses for operating U. S. snag boats H. G. Wright and J. N. Macomb in connection with the work of removing obstructions in Mississippi River during the fiscal year ending June 30, 1902*—Continued.

Application	1902.						
	January.	February.	March.	April.	May.	June.	Total.
Office expenses	$1,005.60	$4.20	$1,079.74	$198.98	$996.50	$12.30	$5,428.34
Expenses of snag boat H. G. Wright:							
Crew	2,101.00	2,131.00	1,862.83	1,392.50	1,456.05	1,424.00	22,510.72
Outfit		35.00		159.05	1,350.33	4,323.50	5,907.88
Fuel	543.80	1,073.80	186.00	367.25	80.00		5,967.33
Subsistence	333.62	482.92	208.84	118.22	139.81	419.11	4,874.26
Supplies				243.30	237.32		750.26
Repairs				406.05	880.53	111.09	1,592.88
Miscellaneous							
Expenses of snag boat J. N. Macomb:							
Crew	2,114.00	2,156.00	2,159.00	1,370.67	1,360.00	1,357.00	23,092.84
Outfit				242.84	912.04	4,385.48	5,540.36
Fuel	830.25	780.00	1,492.00	206.25	107.61		9,783.69
Subsistence	412.93	296.82	485.32	110.66	139.81	419.09	4,805.19
Supplies				410.11	214.72		645.33
Repairs				905.16	805.53	5.75	1,716.44
Miscellaneous							24.15
Total	7,341.20	6,959.74	7,473.73	6,131.04	8,680.25	12,457.32	[a]92,639.67

[a] Includes $7,302 liabilities incurred during fiscal year, but remaining unpaid on June 30, 1902.

X 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN OHIO AND MISSOURI RIVERS.

A concise statement of the project for and history of this work will be found in the Annual Report of the Chief of Engineers, U. S. Army, to which this report is an appendix, as well as on page 2631 of the Report of the Chief of Engineers, U. S. Army, for 1900.

Reference should be made to the Report of the Chief of Engineers, U. S. Army, for 1894, pages 1577 et seq., for information relating to the development of the various forms of construction and for a résumé of the various types employed between 1872 and 1894 and to the Reports of the Chief of Engineers, U. S. Army, for 1895 (p. 2059), 1896 (p. 1717), 1897 (p. 2012), 1898 (p. 1698), 1900 (p. 2632), and 1901 (p. 2169) for minor details as to forms of construction.

Since the adoption of this project work has been done substantially according to the methods referred to above at the following localities: Piasa Island, Alton Harbor, mouth Missouri River, St. Louis Harbor, Cahokia chute, Arsenal Island, Horsetail Bar, Carroll Island, Twin Hollows, Pulltight and Beards Island, Chesley Island, Jim Smiths, Sulphur Springs, Foster Island, Lucas, Cornice Island, Calico Island, Michaels Landing, Osborne Field, Rush Tower, Danby Landing, Fort Chartres, Crooks Landing, Turkey Island, Ste. Genevieve, Kaskaskia Island, Horse Island (Chester), Clearyville, Liberty Island, Seventy-six Landing, Hamburg, Devils Island, Minton Point, Cape Girardeau, Commerce Island, Burnham Island, Powers Island, Goose Island, Buffalo Island, and vicinity of Cairo.

PERMANENT IMPROVEMENT.

On account of lack of available funds work was confined to the care and repair of plant, and collection of physical data by reading gauges and measuring volumes of discharge at low stages in continuation of the same class of work begun in 1900, as reported in Annual Report of Chief of Engineers, 1901, pages 2173–2197. Two discharge measurements during the fiscal year 1902 were made, with results as follows:

Measurements of discharge of Mississippi River, 1901–2.

Dates.	Locality.	Gauge readings.			Oscillation.	Width of waterway.	Area of entire cross section.
		St. Louis gauge, 0=166.26 feet above St. Louis datum.	Elevations of water surface above St. Louis datum.				
			St. Louis gauge.	Local gauge.			
						Feet.	*Sq. ft.*
Nov. 8, 1901	Foot of Arsenal street, St. Louis, Mo.	3.40	169.66	168.98	S.	2,284	23,754
Jan. 16, 1902	.....do.......................	1.26	167.52	167.01	S.	2,319	20,516

Dates.	Locality.	Area of cross section below standard low water.[a]	Mean depth.	Elevation of mean bottom above St. Louis datum.	Total volume of discharge.	Mean velocity.	Number of stations.	Method.
		Sq. ft.	*Feet.*	*Feet.*	*C. ft. per sec.*	*Ft. per sec.*		
Nov. 8, 1901	Foot of Arsenal street, St. Louis, Mo.	25,400	10.4	158.6	57,446	2.42	20	Full depth. Rod floats.
Jan. 16, 1902	.....do	27,161	8.9	158.2	43,631	2.13	12	Do.

Running ice.

[a] Standard low water reads 4 feet on the St. Louis gauge and 3.8 feet on the engineer depot gauge.

PLANT AND MATERIAL.

The plant belonging to this improvement has been maintained in condition to be safe and to reduce its deterioration while idle to a minimum. Worn-out items have not been replaced on account of lack of funds and for reasons stated in the Annual Report of the Chief of Engineers, 1901, page 2173.

Mr. D. M. Currie has continued in charge of the duties of principal assistant engineer, with Assistant Engineers William S. Mitchell, John O. Holman, E. D. Libby, and C. D. Lamb.

The district suffered a serious loss in the sudden death of Mr. John O. Holman, on November 19, 1901, while on duty on the river. Mr. Holman was a thoroughly competent engineer, and his services for some twenty years have been faithful and efficient. In November Assistant E. D. Libby was obliged, on account of failing health, to take an extended leave of absence without pay, which terminated on May 28, 1902, when he finally relinquished his position and severed his connection with this district. Assistant William S. Mitchell has remained on duty in local charge of such work as has been done in this district, as has Assistant C. D. Lamb, in charge of the engineer depot. The assistant engineers and office force have performed their duties with customary efficiency and zeal.

ESTIMATES.

The original estimate of the cost of the improvement of the Mississippi River between the mouths of the Ohio and Missouri rivers, as revised in 1883, is $16,397,500.

The total appropriations to date amount to $10,454,999.98. Of this amount $180,000 was allotted by acts and projects for improvement between the Illinois and Missouri rivers, including Altōn Harbor, leaving a balance of $10,274,999.98 to be applied to the project for the general improvement between the mouths of the Ohio and Missouri rivers. The balance of the estimate for the original project for the general improvement between the Ohio and Missouri rivers not appropriated June 30, 1902, is therefore $6,122,500.02.

The amount that has been expended upon the project to this date is $9,541,368.73.

The balance available June 30, 1902, of the amount appropriated is $733,631.25, to which must be added $97.81 received on account of rental of pile drivers under authority of the Secretary of War, a total of $733,729.06, exclusive of outstanding liabilities.

The amount expended during the fiscal year was $72,482.96, of which $72,332.96 was by voucher, $50 by Auditor for the War Department, and $100 reserved by the office of the Chief of Engineers.

The river and habor act approved June 3, 1896, provides—

> That any balance of former appropriations now available and the money hereby appropriated and authorized to be expended for the said section of said river between the mouth of the Missouri River and the mouth of the Ohio River, or so much thereof as may be necessary, shall be expended in the construction of suitable dredge boats, portable jetties, and other suitable appliances, and in the maintenance and operation of the same, with the view of ultimately obtaining and maintaining a navigable channel from St. Louis to Cairo, not less than two hundred and fifty feet in width and nine feet in depth at all periods of the year, except when navigation is closed by ice.

In the $9,541,368.73 above mentioned is included what has been expended for dredge plant, portable jetties, and appliances for temporary improvement of the channel and for operating the same. This amounts to about $587,053.43. Of this $556.50 was expended during the fiscal year for necessary repairs to dredges. The approximate value of this plant at the beginning of the fiscal year was $225,526.27. Since then the depreciation in value, with $556.50 added for repairs, is estimated to be $16,656.96, which has been charged to the loss account, due to suspension of work on account of the failure of appropriations. The approximate value of this plant at this time is therefore $209,425.81.

The available balance includes the unexpended balances from special allotments made by Congress, as follows:

For bank protection at Cairo, Ill., act of July 5, 1884	$2,571.70
For revetting bank opposite mouth of Missouri River, act of March 3, 1899	30,772.84
For protection of bank on Missouri side and to deepen and straighten channel at Wittenberg, Mo., act of March 3, 1899	10,000.00
Total	43,344.54

Money statement.

July 1, 1901, balance unexpended		$156,114.21
Received for expenses of rented pile drivers		97.81
Amount appropriated by river and harbor act approved June 13, 1902		650,000.00
		806,212.02
June 30, 1902, amount expended during fiscal year:		
By vouchers	$72,332.96	
By amount paid by Auditor for War Department	50.00	
By amount reserved by Office Chief of Engineers	100.00	
		72,482.96
July 1, 1902, balance unexpended		733,729.06
July 1, 1902, outstanding liabilities		377.72
July 1, 1902, balance available		[a]733,351.34
Amount (estimated) required for completion of existing project		6,122,500.02
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance available July 1, 1902:		
For works of improvement	$850,000.00	
For maintenance of improvement	150,000.00	
		1,000,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

LIST OF APPROPRIATIONS.

By act of—		By act of—	
June 10, 1872	$100,000.00	March 3, 1893	$658,333.33
March 3, 1873	200,000.00	August 18, 1894	758,333.33
June 23, 1874	200,000.00	March 2, 1895	758,333.33
March 3, 1875	200,000.00	June 3, 1896	275,000.00
August 14, 1876	200,000.00	June 4, 1897	673,333.33
June 18, 1878	240,000.00	July 19, 1897	325,000.00
March 3, 1879	200,000.00	July 1, 1898	673,333.33
June 14, 1880	250,000.00	March 3, 1899	673,333.33
March 3, 1881	600,000.00	June 6, 1900	100,000.00
August 2, 1882	600,000.00	June 13, 1902	650,000.00
July 5, 1884	520,000.00	Other receipts	97.81
August 5, 1886	375,000.00		
August 11, 1888	300,000.00		
September 19, 1890	400,000.00	Total	10,455,097.79
July 13, 1892	525,000.00		

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[a] Distributed under subheadings as follows:

For bank protection at Cairo, Ill., act of July 5, 1884	$2,571.70
For revetting bank opposite mouth of Missouri River, act of March 3, 1899	30,772.84
For from mouth of Ohio River to mouth of Missouri River, acts of June 6, 1900, and June 13, 1902	690,006.80
For protection of bank on Missouri side and to deepen and straighten channel at Wittenberg, Mo., act of March 3, 1899	10,000.00
	733,351.34

COMMERCIAL STATISTICS.

Receipts and shipments at St. Louis, Mo., during the year 1901.

	Tons.
Receipts:	
Barbed wire, ores, and metals (pig and manufactured)	1,800
Coal and coke	52,515
Cotton and cotton products	1,173
Groceries and dairy products	24,008
Hay, seed, grain, flour, meal, etc	60,981
Live stock and products	23,450
Lumber	29,380
Merchandise and sundries	262,080
Vegetables and fruits	7,222
White lead, oils, etc	15
Wines and liquors	9
Wool	172
Total	462,805
Shipments:	
Barbed wire, ores, and metals (pig and manufactured)	1,812
Coal and coke	10,123
Cotton and cotton products	412
Groceries and dairy products	8,568
Hay, seed, grain, flour, meal, etc	101,879
Live stock and products	5,153
Lumber	920
Merchandise and sundries	72,490
Vegetables and fruits	2,256
White lead, oils, etc	716
Wines and liquors	4,941
Wool	1
Total	209,271

Transferred by ferries across the river at St. Louis.

	Tons.		Tons.
1898	4,033,871	1900	5,218,967
1899	5,036,730	1901	5,860,592

Shipments of grain, including flour, meal, etc., and coal, down the river from landings between St. Louis and Cairo, during the year 1901, amounted to 30,978 tons.

List of steam-power boats that arrived at St. Louis during the year 1901.

Size of boats.	Draft.	Number.	Times arrived.
	Feet.		
Under 500 gross tons	2.5 to 6	108	1,797
Between 500 and 1,000 gross tons	4 to 7.6	6	816
Total		114	2,113

List of barges and scows that arrived at St. Louis during the year 1901.

Size of boats.	Draft.	Number.	Times arrived.
	Feet.		
Under 500 gross tons	2.5 to 7.5	224	507
Between 500 and 1,000 gross tons	5.2 to 8	17	51
Over 1,000 gross tons		2	8
Total		243	566

List of steamers and barges permanently enrolled and licensed at the port of St. Louis on the 31st day of December, 1901.

	Number of vessels.	Gross tonnage.	Net tonnage.
Permanently enrolled:			
Steamers (wood)	80	26,307	23,678
Steamers (iron and steel)	8	2,999	2,325
Barges (wood)	49	37,874	37,805
Barges (steel)	2	2,324	2,324
Gasoline vessels	1	27	25
Yachts	5	324	237
Permanently licensed:			
Steamers under 20 tons (wood)	6	65	48
Steamers under 20 tons (iron)	1	26	13
Barges under 20 tons	2	21	21
Gasoline vessels under 20 tons	8	89	74
Yachts under 20 tons	4	42	37
Total	166	70,098	66,587

Cost of works during fiscal year ending June 30, 1902, St. Louis Harbor.

Expenditures.	Bischoff dike.		Long dike.		Hurdle No. 10, main line.	
	Quantity.	Cost.	Quantity.	Cost.	Quantity.	Cost.
Labor and subsistence		$2,152.18		$1,802.36		$4,444.85
Office and general expense		328.80		287.70		548.27
Plant		428.51		366.63		1,008.35
Piles, feet					15,760	1,871.12
Stone, cubic yards	2,910	2,857.30	2,800	2,749.31	4,250	4,257.59
Wire, pounds	1,600	50.08	1,470	46.01	3,330	104.23
Lumber, mattress, feet	58,000	785.90	56,000	758.80	85,240	1,155.00
Material, miscellaneous		89.33		79.99		436.31
Total		6,692.10		6,090.80		13,825.72
Work done:						
Linear feet	425	@ 15.75	300	@ 20.30	335	@ 39.78
Square feet	41,380	@ .162	35,950	@ .17	95,475	@ .139

Expenditures.	Hurdle No. 10, teehead.		Surveys.		Total.
	Quantity.	Cost.	Quantity.	Cost.	
Labor and subsistence		$503.10		$2,628.86	$11,531.35
Office and general expense		82.20		208.17	1,455.14
Plant		107.46		294.15	2,205.10
Piles, feet	4,114	857.92			1,729.04
Stone, cubic yards	470	404.82			10,269.02
Wire, pounds	1,000	31.80	100	3.13	234.75
Lumber, mattress, feet	29,327	397.38			3,097.08
Material, miscellaneous		60.44		50.42	716.49
Total		1,944.62		3,184.73	31,287.97
Deterioration of barges from 1891 to 1902					6,713.09
Total					37,951.06

Surveys.

Expenditures.	Cost.
Labor and subsistence	$2,191.05
Office and general expense	74.70
Plant	525.63
Wire	3.13
Material, miscellaneous	217.40
Total	3,011.91

Repairs of gauges, etc	$1,981.91
St. Louis wharf line, etc	1,060.00

Total cost of works, etc., to June 30, 1902.

Locality.	Prior to July 1, 1901.	During year ending June 30, 1902.	Total to June 30, 1902.
Mississippi River between Ohio and Missouri rivers	$8,323,412.10		$8,323,412.10
St. Louis Harbor, hurdles, 1891, 1892, 1902	144,048.94	$37,951.06	182,000.00
Total	[a] 8,467,461.04	37,951.06	8,505,412.10
Portable jetties, 1895 to 1902	[a] 114,603.53		114,603.53
Dredging	[a] 246,367.13		246,367.13
Surveys	[a] 212,448.28	3,011.91	215,460.19
Total	9,040,879.98	40,962.97	9,081,842.95

[a] See Appendix Y, page 2183, Annual Report of Chief of Engineers, 1901.

Property account.

Class of property.	Value July 1, 1901.	Debits.	Credits.	Value June 30, 1902.
Steamer Gen. T. L. Casey	$10,800.99		$1,559.39	$9,241.60
Steamer Gen. H. L. Abbot	20,315.60	$189.67	3,122.74	17,382.53
Steamer Wm. R. King	65,753.60	4,881.91	8,767.94	61,867.57
Dredge No. 1	10,157.81		1,466.54	8,691.27
Dredge No. 2	13,543.74		1,955.38	11,588.36
Dredge No. 3	97,583.56	278.25	6,045.43	91,816.38
Dredge No. 4	95,437.73	278.25.	5,918.62	89,797.36
Steam tenders, wood	10,835.00	492.74	2,057.04	9,270.70
Steam tenders, steel	53,139.04	653.13	3,793.65	49,998.52
Barges, model	110,836.88	5,008.55	27,723.71	88,121.72
Quarter boats	21,415.34	395.56	3,487.40	18,223.50
Office and survey boats	6,771.87	302.93	1,280.62	5,794.18
Pile drivers	50,206.91	1,173.39	7,999.17	43,381.13
Derrick boats	3,047.34		439.96	2,607.38
Derricks	3,385.94		488.85	2,897.09
Machine shops	1,692.96		244.42	1,448.54
Small boats	20,793.50	11,521.65	5,306.25	27,008.90
Portable quarters	2,228.35		321.71	1,906.64
Jetty gates	8,803.43		1,270.99	7,532.44
Ways (engineer depot)	4,475.20	13.50	659.61	3,829.09
Wharf boat	171.12	577.76	602.46	146.42
Engineer depot	4,740.32	243.36	927.74	4,055.94
Tools and appliances	13,552.87	1,289.64	2,832.65	12,009.86
Boarding outfit	18,288.60	256.44	2,896.86	15,648.18
Office furniture	724.32		108.65	615.67
Survey instruments	1,547.04		223,34	1,323.70
Photographic apparatus	257.14			[a] 257.14
Total	650,506.20	27,556.73	91,501.12	586,561.81

[a] Transferred March 22, 1902, to First Lieut. S. A. Cheney, Corps of Engineers.

Material account.

Class of material.	Value July 1, 1901.	Debits.	Credits.	Value June 30, 1902.
Subsistence	$636.51	$7,246,22	$7,660.48	$222.25
Piles	7,075.76	423.12	1,794.73	5,704.15
Stone	2,025.00	9,643.07	10,269.02	1,399.05
Rope	16,596.86		105.57	16,491.29
Wire	567.90		237.88	330.02
Iron	6,280.31	923.14	55.92	7,147.53
Nails	422.67		78.52	344.15
Spikes	972.36		10.73	961.63
Lumber:				
Miscellaneous	8,474.50	574.96	735.65	8,313.81
Mattress		3,573.06	3,137.73	435.33
Oakum	75.24	655.00	486.99	243.25
Coal	3,119.53	3,860.36	5,905.40	1,074.49
Ice		490.67	490.67	
Material, miscellaneous	12,696.79	802,41	2,781.43	10,717.77
Total	58,943.43	28,192.01	33,750.72	53,384.72

Engineer Office, United States Army, in account with United States, from 1870 to June 30 1902.

	To allotments, appropriations, etc., prior to July 1, 1901, as per Appendix Y, page 2187, Annual Report of Chief of Engineers for 1901:		
1872–1880.	Allotment for surveys	$51,208.77	
1876–1897.	Special appropriations	401,600.00	
1879–1900.	Miscellaneous receipts	2,113.17	
1872–1900.	Appropriations for general improvement	9,829,999.98	
			$10,284.921.92
June 13, 1902.	To appropriation for Mississippi River between Ohio and Missouri rivers	650,000.00	
Oct. 17, 1901.	To St. Louis and Southern Illinois Railroad Company, use of pile driver	36.28	
Dec. 20, 1901.	To J. B. Myers, use of pile driver	28.45	
May 19, 1902.	To J. B. Myers, use of pile driver	33.08	
			650,097.81
June 30, 1902.	To nonpayments:		
	Unpaid percentage on annulled contract	900.17	
	Unpaid labor	3,214.71	
	Unpaid miscellaneous	374.52	
			4,489.40
	Total		10,939,509.13
June 30, 1902.	By construction between Illinois and Missouri rivers:		
	Piasa Island Dam	37,910,41	
	Piasa Island Dam, cutting channel	3,116.86	
	Alton Dam	33,740.05	
	Alton Dike	126,652.74	
			201,420.06
	By construction between Ohio and Missouri rivers		8,505,412.10
	By jetties		114,603.53
	By dredging		246,367.13
	By surveys and gages		215,460.19
	By amounts withdrawn for office of Chief of Engineers		2,220.50
	By loss account		273,919.47
	By property on hand		586,561.81
	By material on hand		53,384.72
	By appropriations unexpended:		
	Mississippi River, Ohio to Missouri	$733,729.06	
	Beech Ridge, Illinois	6,430.56	
			740,159.62
	Total		10,939,509.13

X 3.

IMPROVEMENT OF HARBOR AT ST. LOUIS, MISSOURI.

A concise statement of the project for and history of this work will be found in the Report of the Chief of Engineers to which this report is an appendix and on page 2664 of the Report of the Chief of Engineers for 1900.

The amount expended to June 30, 1901, was $150,762.03. There was expended during the fiscal year $31,237.97.

The hurdles constructed for the purpose of this improvement are in good condition and fully serve their object, excepting as to their channel ends, which have been more or less worn away by ice, drift, and undermining.

The work at this locality during the past fiscal year consisted in raising and strengthening the river ends of Long and Bischoff dikes and in repairing and extending hurdle No. 10 to the channel limit line, as shown on the revised project, dated October 8, 1901.

Long Dike.—This dike projected from the high bank into the river 325 feet, with its crest about 6.8 feet above low water, and was from 15 to 20 feet in width. It was raised with stone on an even slope to the high bank at the level of a 24-foot stage, from a point 160 feet from said high bank, where the crest was at the 7.4-foot stage.

The width of the new work was made 6 feet on top, with slopes of 1 on 1 upstream and 1 on 1½ to 1 on 2 on the lower side, running into the revetment at the base. The groins on both sides of the dike were filled with stone. The bank was protected 100 feet above and 200 feet below the dike by lumber mattresses below low water and by stone revetment above, the mattresses extending around the projecting end of the dike to protect it against overfall.

Bischoff Dike.—This dike jutted out 535 feet from the high bank and 300 feet beyond the low-water shoreline, with its crest rising gradually from the level of standard low water to 8 feet above that plane. The width of exposed stonework was 20 to 25 feet.

The work done in extension and repair was, in general, similar to that just described for Long Dike.

Beginning at a point 265 feet from the river end, where the elevation of the crest was about at the 9-foot stage, the stonework was raised on a slope, for 270 feet, to the 24-foot stage at the high bank. The new work was 6 feet wide on top, lying north of the center line of the old dike, and the groins at the bottoms of the slopes were filled and the banks above and below the structure revetted as at Long Dike; but the protection mattress was carried only 15 feet beyond the river end of the new stonework, as the very deep water around the river end of the dike indicated that the maximum effect of overfall had probably been reached, and that, after so many years standing, the foundation should be secure.

Hurdle No. 10.—This hurdle had been partly destroyed for 325 feet from its river end. In 250 feet of this distance the stumps of the piling alone remained.

In the restoration a new pile was jetted down alongside each stump and was securely wired to it. The tops of the new piles were bolted to stringers and the line supported by brace piles running back to a ground stringer secured in front of the stumps of the old brace piles, and this was covered and reenforced with stone massed behind it and merging into the revetment.

The hurdle was repaired and extended (375 feet) in the ordinary form of piling in two rows, strengthened by a third at the river end of the line, of staggered three-pile clumps with stringers between the rows, all piles being driven through a lumber foundation mattress 120 feet wide. On either side of the piling narrow lumber mattresses, some 15 feet in width, were laid and the shallow trench formed between them was filled with stone, thus completely covering that portion of the foundation mattress which had been broken by the penetration of the piles. A T-head was built at the river end of the line, consisting of pile clumps in two rows on a foundation mattress and projecting 50 feet above and 100 feet below the line of the hurdle. At the junction of the T-head and the main line of the hurdle a buttress of stone was raised to the 15-foot stage with the greater portion of its mass lying in the angle above the hurdle, and with its crest line sloping to low water at the ends of the T-head piling.

Surveys.—Surveys were made which connected the harbor at St. Louis with the general triangulation of the river, and located on the ground points on the St. Louis wharf line as fixed by ordinance.

Plant.—The plant belonging to the improvement of the Mississippi River between the Ohio and Missouri rivers, used in connection with this work, was repaired as required.

Material.—The lumber and part of the stone required were purchased in open market, while the balance of the stone and the piles were transferred from what was on hand for general use in the improvement of the Mississippi River between the Ohio and Missouri rivers.

ESTIMATES.

No further appropriation is asked for this work.

The commercial statistics pertaining to this portion of the river will be found in the report on the improvement of the Mississippi River between the mouth of the Ohio and the mouth of the Missouri rivers.

This work is in the collection district of New Orleans. The nearest port of entry is St. Louis, Mo., at which place the customs collected during the fiscal year ending June 30, 1902, amounted to $1,885,698.98. The amount of internal revenue collected was $13,009,406.81.

Money statement.

July 1, 1901, balance unexpended	$31,237.97
June 30, 1902, amount expended during fiscal year	31,237.97

APPROPRIATION.

By act of September 19, 1890	$182,000

X 4.

TO PREVENT THE MISSISSIPPI RIVER FROM BREAKING THROUGH INTO THE CACHE RIVER AT OR NEAR A POINT KNOWN AS BEECH-RIDGE, A FEW MILES ABOVE CAIRO, ILLINOIS.

A statement of the history of this work, together with the approved project for the expenditure of the appropriation of June 4, 1897, and the resulting operations to June 30, 1902, will be found in the Report of the Chief of Engineers to which this report is an appendix.

The amount expended to June 30, 1901, was $93,569.44. There were no expenditures during the past fiscal year. The balance on hand June 30, 1902, $6,430.56, is estimated to be sufficient to extend the existing bank protection to a length of about 10,000 feet and raise it to about the 30-foot stage, Cairo gauge.

Money statement.

July 1, 1901, balance unexpended	$6,430.56
July 1, 1902, balance unexpended	6,430.56
July 1, 1902, outstanding liabilities	3.50
July 1, 1902, balance available	6,427.06

APPENDIX Y.

OPERATING SNAG BOATS AND DREDGE BOATS ON UPPER MISSISSIPPI RIVER; IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN MOUTH OF MISSOURI RIVER AND ST. PAUL, MINNESOTA, AND OF LA CROSSE HARBOR, WISCONSIN; OPERATING AND CARE OF GALENA RIVER IMPROVEMENT, ILLINOIS, AND OF ILLINOIS AND MISSISSIPPI CANAL AROUND THE LOWER RAPIDS OF ROCK RIVER, ILLINOIS.

REPORT OF MAJ. C. McD. TOWNSEND, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Operating snag boats and dredge boats on Upper Mississippi River.
2. Mississippi River between mouth of Missouri River and St. Paul.
3. Operating and care of Des Moines Rapids Canal and Dry Dock.
4. Operating and care of Illinois and Mississippi Canal around Lower Rapids of Rock River, at Milan, Illinois.
5. Operating and care of Galena River improvement, Illinois.
6. Harbor at La Crosse, Wisconsin.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 7, 1902.

GENERAL: I have the honor to transmit the annual report on improvement work in this district for fiscal year ending June 30, 1902.

Very respectfully, your obedient servant,

C. McD. TOWNSEND,
Major, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. A.

Y 1.

OPERATING SNAG BOATS AND DREDGE BOATS ON UPPER MISSISSIPPI RIVER.

The work performed under this appropriation consists in the removal of snags, wrecks, rocks, and similar obstructions to navigation. The operations extend from Minneapolis to the mouth of the Missouri River, a distance of about 670 miles,[a] following the low-water channel.

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[a] A new and accurate measurement of distance from Minneapolis to Missouri River gives 670 miles, which is 54 miles shorter than the distance heretofore stated.

The plant belonging to the work consists of the snag boats *Col. A. Mackenzie* and *J. G. Parke*, but dredges, drill boats, and tenders are borrowed from other appropriations when required. The snag boats were built in 1900 and 1882.

The general improvement of the river has so reduced the extent of caving banks that but one snag boat is required, the *J. G. Parke* being employed as a towboat.

The details of work accomplished are given in the appended report of Assistant Engineer C. W. Durham.

The total tonnage of the river between Falls of St. Anthony and mouth of Missouri River for the calendar year 1901 was, approximately, 2,125,000 tons, and the ton-miles 531,250,000. This includes logs and lumber.

Money statement.

June 30, 1902, amount drawn from Treasury under permanent appropriation	$25,000.00
June 30, 1902, amount expended during fiscal year	25,000.00
July 1, 1902, amount available under permanent appropriation of August 11, 1888, for fiscal year ending June 30, 1903	25,000.00

ABSTRACT OF APPROPRIATIONS AND ALLOTMENTS.

By act approved March 2, 1867	$96,000
By allotment from appropriation of July 25, 1868	26,000
By allotment from appropriation of 1869	35,640
By act approved—	
July 11, 1870	36,000
March 3, 1871	42,000
June 10, 1872	42,000
March 3, 1873	25,000
June 23, 1874	25,000
March 3, 1875	25,000
August 14, 1876	30,000
June 18, 1878	41,500
March 3, 1879	20,000
June 14, 1880	8,000
March 3, 1881	25,000
By act passed August 2, 1882	25,000
By act approved August 5, 1886	22,500

By act of August 11, 1888, for fiscal year ending—	
June 30, 1889	$25,000
June 30, 1890	25,000
June 30, 1891	25,000
June 30, 1892	25,000
June 30, 1893	25,000
June 30, 1894	25,000
June 30, 1895	25,000
June 30, 1896	25,000
June 30, 1897	25,000
June 30, 1898	25,000
June 30, 1899	25,000
June 30, 1900	24,944
June 30, 1901	25,000
June 30, 1902	25,000
Total	874,584

STATISTICS OF COMMERCE AND NAVIGATION.

Lumber.—The most important business carried on in connection with the navigation of the Upper Mississippi River and its principal tributaries is the lumber trade, which gave employment in 1901 to about 75 towboats, valued at $400,000. Along the river from Minneapolis to St. Louis 55 sawmills were operated by 50 wholesale lumber firms, having an invested capital of about $25,000,000. Their manufactures of white pine in 1901 were: Lumber, 1,107,432,000 feet B. M.; shingles, 196,486,000; lath, 265,453,000, and of hemlock lumber 6,971,000 feet B. M. In addition to the manufactures there are a great many retail or distributing firms.

Lumber manufacture, Upper Mississippi River Valley, 1901.

[Value, about $30,000,000.]

Locality.	Lumber.	Shingles.
	Feet B. M.	*Number.*
Above Minneapolis	471,526,000	79,774,000
Minneapolis	624,513,000	54,709,000
St. Paul to St. Louis	460,036,000	127,723,000
St. Croix River	251,582,000	54,522,000
Black River	156,485,000	63,097,000
Chippewa River	27,183,000	15,613,000
Total	1,991,325,000	395,438,000

The larger part of the above was floated for greater or less distance on the Mississippi River either as logs or lumber.

Statement of distribution of lumber manufacture along the Upper Mississippi River from Minneapolis to St. Louis in 1901.

Locality.	Lumber.	Shingles.	Lath.
	Feet B. M.	*Number.*	*Number.*
Minneapolis	624,513,000	54,700,000	149,377,000
Hastings	3,000,000	500,000	800,000
Redwing	8,539,000	1,980,000	2,029,000
Winona	72,500,000	39,600,000	29,450,000
La Crosse	22,883,000	14,113,000	5,132,000
Guttenberg	12,000,000	3,000,000	1,500,000
Dubuque	52,500,000	10,500,000	8,500,000
Bellevue	4,000,000	....	2,000,000
Clinton	66,420,000	13,620,000	10,800,000
Davenport	36,010,000	3,768,000	6,711,000
Rock Island	68,000,000	9,517,000	18,483,000
Muscatine	51,644,000	11,561,000	10,028,000
Burlington	28,500,000	3,200,000	8,400,000
Fort Madison	18,760,000	10,730,000	3,613,000
Keokuk	8,000,000	3,500,000	2,500,000
Quincy	30,163,000	16,197,000	6,130,000
Total	1,107,432,000	196,486,000	265,453,000

Steamboats and freight.—There were employed as rafters during the season of 1901 between St. Paul and St. Louis, 75 stern-wheel steamboats, large and small; 21 stern-wheel and 2 side-wheel packets; 5 contractors' stern-wheel boats; 37 pleasure boats, some of which have propellers; 11 ferryboats, and 16 Government boats, of which 2 are side-wheelers; in all, 167 steamboats.

The principal steamboat lines on the Upper Mississippi River are the Diamond Jo, the Eagle, the Carnival City, and the Acme packet companies. There are also independent boats carrying freight and passengers. During the season of 1901 the amount of freight and number of passengers could not be accurately ascertained, but tolerably complete reports give 125,000 tons of freight and 454,553 passengers, not including those of ferryboats. Taking into consideration the logs and lumber floated down the stream, the gross tonnage for 1901 was approximately 2,125,000 tons, and from tolerably accurate information of the distances freight was carried, the estimated ton-miles are 531,250,000.

Statement of approximate tonnage of the Upper Mississippi River, Minneapolis to St. Louis, for the year 1901 was 2,125,000.

At St. Louis there were received in 1901 from the Upper Mississippi River by boats, barges, and rafts 119,020 tons of merchandise, including logs, pine lumber, and shingles. There were shipped to points on the Upper Mississippi River 23,392 tons of merchandise.

Arrivals and departures from St. Louis during 1901.

Steamboats and barges from Upper Mississippi River arrived at St. Louis	653
Steamboats and barges departed from St. Louis for Upper Mississippi River	632

The following shows the navigation during the period of 1901 through Winona Bridge, at which point the traffic is greatest: Steamboats, 3,148; barges, 1,146; rafts, 974.

The following table affords a view of the amount of navigation at various localities on the Upper Mississippi River for the year 1901:

List of steamboats, barges, and rafts passing through various bridges.

Locality of bridge.	Steamboats.	Barges.	Rafts.
St. Paul Park	1,658	(a)	(a)
Hastings	1,740	274	593
Prescott	3,110	(a)	(a)
Winona	3,148	1,146	974
La Crosse	2,378	639	520
Dubuque	1,585	1,136	405
Sabula	1,276	485	254
Clinton	2,142	450	b 155
Rock Island	2,119	508	298
Keithsburg	574	128	81
Burlington	1,185	294	59
Fort Madison	1,096	305	87
Keokuk	1,053	185	44
Quincy	1,334	270	78
Hannibal	715	425	22
Louisiana	723	240	42
Alton	1,931	574	30

[a] No record.

[b] Partial record.

Internal revenue for the year ending December 31, 1901, collected in districts bordering on the Upper Mississippi River.

Locality.	Office.	Amount.
Minnesota	St. Paul	$2,442,724.28
Second Wisconsin	Madison	1,162,995.40
Third Iowa	Dubuque	767,148.97
Fourth Iowa	Burlington	813,872.39
Fifth Illinois	Peoria	31,809,826.05
Eighth Illinois	Springfield	10,580,175.92
Thirteenth Illinois	East St. Louis	1,072,592.89
First Missouri	St. Louis	14,490,581.84
Total		63,139,917,74

Customs revenue and tonnage for the year ending December 31, 1901.

Port.	Collections.	Tonnage enrolled.	Vessels.
St. Paul, Minn	$725,176.96	896.24	14
La Crosse, Wis	18.50	3,816.00	47
Dubuque, Iowa	29,133.28	3,360.00	14
Rock Island, Ill	5.40	8,272.00	118
Burlington, Iowa	42.77	89.32	89
St. Louis, Mo. [a]	1,903,393.66	66,599.00	167
Total	2,657,770.57	83,032.56	449

[a] Only a part of the St. Louis statement is applicable to the Upper Mississippi.

Summary of expenditures for operating snag boats and dredge boats on Upper Mississippi River for fiscal year ending June 30, 1902.

Month.	Office expenses, superintendence, and contingencies.	Care, repair, and operating snag boats and dredge boats.						Grand total.
		Labor.	Subsistence.	Fuel.	Expense.	Repairs.	Total.	
1901.								
July	$150.00	$2,430.69	$384.29	$177.84	$316.19	$71.79	$3,380.80	$3,530.80
August	150.00	2,125.91	446.03	1,108.78	1,140.09	5.15	4,825.96	4,975.96
September	150.00	2,352.72	83.00	347.95	182.80	23.14	2,989.61	3,139.61
October	150.40	1,772.84	582.59	839.37	81.18	80.33	3,356.31	3,506.71
November	154.59	215.00	....	40.61	104.88	....	360.49	515.08
December	150.00	218.59	....	....	....	16.31	234.90	384.90
1902.								
January	150.00	215.00	....	....	....	16.34	231.34	381.34
February	150.00	215.00	....	....	38.56	85.06	338.62	488.62
March	413.75	215.00	....	....	....	10.00	225.00	638.75
April	150.00	1,023.49	352.05	108.80	621.63	414.85	2,520.82	2,670.82
May	150.00	1,245.00	185.33	368.79	38.93	....	1,838.05	1,988.05
June	150.00	1,235.00	247.97	532.05	469.53	144.81	2,629.36	2,779.36
Total	2,068.74	13,264.24	2,281.26	3,524.19	2,993.79	867.78	22,931.26	25,000.00

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 1, 1902.

MAJOR: I have the honor to present my report on the operations of snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1902.

Operations of snag boat Col. A. Mackenzie.—The *Mackenzie*, leaving Rock Island on July 3, 1901, covered her entire district from St. Paul to the mouth of the Missouri River during the month, removing snags and other obstructions and making an inspection trip, with the division engineer on board, from St. Paul to St. Louis. Snags and other obstructions were removed at or near Johnsons Island (mile 424), Keithsburg (mile 416), New Boston (mile 410), Turkey Island (mile 406) Port Louisa (mile 405) Fulton (mile 328), Arnolds Landing (mile 301), Bellevue (mile 290), Cassville Slough (mile 234), Minneiska (mile 85), Redwing (mile 49), Smiths Bar (mile 37), Prescott (mile 30), Sand Prairie (mile 299), Oquawka (mile 431), and Clarksville (mile 579).

Leaving Alton August 1, the *Mackenzie* proceeded up river, and arrived at St. Paul on the 31st. On this trip snags and other obstructions were removed at or near Squaw Island (mile 632), Tisdales Towhead (mile 588), Clarksville (mile 579), Hickory Chute (mile 563), Atlas Island (mile 558), Cincinnati Landing (mile 555), Armstrong Island (mile 536), Whitneys (mile 534), Marion City (mile 529), Tully Island (mile 502), Alexandria (mile 490), Sauerweins (mile 448), Drew Chute (mile 439), Otter Island (mile 438), Johnsons Island (mile 424), Keithsburg (mile 416), New Boston (mile 410), Turkey Island (mile 406), Hershey Chute (mile 358), Oquawka (mile 431), Port Louisa (mile 405), Sabula (mile 312), Sand Prairie (mile 299), Bellevue (mile 290), Maquoketa Slough (mile 256), Ninemile Island (mile 272), La Crosse (mile 145), Zumbro River (mile 97), and Newport Island (mile 10).

On August 23 and 24 examinations of the river were made in the vicinity of Bellevue (miles 284–291). Dredge *Vulcan* was taken down from Fountain City to La Crosse, where she removed a portion of a crib obstructing the channel, and was then towed back to Fountain City. At Hamburg (mile 593) a barge wreck was removed.

On September 5 the *Mackenzie* left St. Paul for down river, and reached St. Louis on the 16th; returning up river, she tied up at Glenhaven on the 30th. A continuous line of channel soundings was made from the mouth of the Missouri River (mile 658) to Glenhaven (mile 226).

A survey of the river at Hamburg (mile 593) was made on the 30th.

During September snags and other obstructions were removed at or near De Soto (mile 176), Ferry Slough (mile 227), Cassville Slough (mile 234), Buena Vista (mile 240), Hurricane Island (mile 246), Maquoketa Slough (mile 256), Bellevue Slough (mile 290), Keithsburg (mile 416), Lagrange (mile 513), Fabius Island (mile 527), Hickory Chute (mile 563), Tisdales Towhead (mile 588), Turners (mile 606), Sandy Island (mile 610), and Squaw Island (mile 632). In October, leaving Glenhaven on

the 1st with the division engineer on board, she reached St. Louis on the 7th, and thence returning up river, arrived at Rock Island on the 22d, where she remained three days for enlargement of steam heating plant; she then proceeded to Keokuk, and was laid up for the winter on the 31st, above the middle lock of the Des Moines Rapids Canal. Snags and other obstructions were removed on her up trip from St. Louis at or near Squaw Island (mile 632), Two Branch Island (mile 623), Becks Landing (mile 622), Stag Island (mile 602), Sterling Island (mile 600), Wildwood (mile 596), Eagle Island (mile 581), Hickory Chute (mile 563), Whitneys (mile 534), Fabius Island (mile 527), Dasher Slough (mile 433), Johnsons Island (mile 424), Keithsburg (mile 416), Turkey Island (mile 406), Port Louisa (mile 405).

During the season of 1901 the practice of destroying large stumps on the bank by means of dynamite and rackarock was inaugurated, and stumps to the number of 327 were so destroyed. Rackarock proved to be the more effective explosive.

In 1902, the *Mackenzie* having received miscellaneous repairs, left her winter quarters on April 17 and proceeded down river to St. Louis (mile 676). Leaving St. Louis on the 23d, she returned up river, arriving at St. Paul June 6. On this trip snags and other obstructions were removed at or near Turners Landing (mile 605), Stag Island (mile 604), Sterling Island (mile 600), Grimes Island (mile 587), Hickory Chute (miles 562–563), Atlas Island (mile 560), Cincinnati Landing (mile 554), Armstrong Island (mile 536), Beebe Island (mile 532), Twin Island (mile 449), Otter Island (mile 438), Dasher Island (mile 433), Oquawka (mile 431), Johnsons Island (mile 424), Keithsburg (mile 415), New Boston (mile 411), Turkey Island (mile 407), Port Louisa (mile 403), Illinois Slough (mile 401), Hershey Chute (mile 388), Santa Fe (mile 304), Arnolds (mile 301), Harris Slough (mile 278), Nine Mile Island (mile 275), North McGregor (mile 208), La Crosse (mile 145), Minneiska (mile 99), and Redwing (mile 51). On above-mentioned trip many buoys were placed and a survey of Galena River improvement was made.

The *Mackenzie* left St. Paul June 9 and proceeded down river, arriving at St. Louis on the 21st; returning up river, she tied up at the foot of Hickory Chute on the night of June 30. On this trip 5 barges were towed from Dubuque (mile 265) to Keokuk (mile 484), one barge from St. Paul to Fountain City (mile 108), and snags, etc., were removed at or near Lansing (mile 177), Crooked Slough (mile 189), Johnsons Island (mile 422), Enterprise Island (mile 629), Stag Island (mile 602), Westport Island (mile 598), Tisdales Towhead (mile 587), Clarksville (mile 577), and Hickory Chute (mile 563).

Assistance was given to the wrecked steamer *Ravenna* on June 16.

Summary of operations of snag boat Col. A. Mackenzie for fiscal year ending June 30, 1902.

Snags removed	294
Stumps destroyed	500
Leaning trees pulled back	264
Leaning trees felled	2,252
Wrecks removed	2
Steamboat assisted	1
Surveys, days	5
Buoys placed	44
Miles run	6,554

The new boat gave good satisfaction and the amount of work performed by her was larger than has been accomplished in any year since 1895.

Summary of operations of snag boats and dredge boats on Upper Mississippi River for fiscal year 1902.

	Snags removed.	Leaning trees felled and removed.	Leaning trees pulled back.	Stumps destroyed.	Wrecks and cribs removed.	Sand and gravel removed (cubic yards).	Rock removed (solid cubic yards).	Miles run.
Snag boat Mackenzie; dredges Vulcan, Phoenix, and Ajax	294	2,252	264	500	2	17,770	1,735	6,554
Total, 1900–1902	592	5,879	702	535	6	23,770	6,465	19,615
Total, 1868–1899	9,484	75,969	1,607	....	77	171,920	4,034	150,647
Grand total, 1868–1902	10,076	81,848	2,309	535	83	195,690	10,499	170,262

List of rocks and wrecks between St. Paul and mouth of Missouri River that are or may become obstructions to navigation.

	Mile.
Rocks in draw of Omaha bridge at St. Paul	1
Rocks about 500 feet above Picayune Island (No. 114)	150
Barge near foot of Coon Slough, at Island 124, near shore	161
Steamer *Ruby*, below Glenhaven	229
Steamer *Hudson*, one mile below Guttenberg	229
Steamer *Dr. Franklin*, at foot of Maquoketa Chute	259
Rocks at Rock Island Rapids	348–362
Rocks opposite Rockingham	367
Rocks at Horse Island, above and opposite	369
Rocks at and near head of Smiths Island (No. 317)	370
Rocks near shore above Linwood	370
Rocks near shore at Buffalo	372
Rocks near shore at Montpelier	377
Rocks near shore at Fairport and above	382
Rocks above Muscatine Bridge	390
Rocks about 3 miles below Muscatine, in midriver	393
Barge and sawmill runway at Port Louisa	404
Rocks opposite New Boston, in midriver	412
Rocks at mouth of Edwards River, near shore	414
Barge near shore 1 mile below Edwards River	415
Rocks below Keithsburg	418
Barge below Benton Island	428
Barge in bar below Oquawka	430
Rocks opposite Pontoosuc	457
Rocks at Des Moines Rapids	473–484
Rocks below Keokuk Bridge	484
Barge opposite lower sawmill at Keokuk	485
Rocks at Bludsoes, in midriver	491
Rocks opposite middle of Orton Island	525
Steamer *Dubuque*, above Mundys Landing	556
Ice breaker outside of Louisiana waterworks	567
Steamer *Mohawk*, at head of Clarksville Island	578

Removing portion of Dam 48, near Teepeeota Point.—This wing dam (mile 84) encroached upon the projected channel, and 175 linear feet of it was removed by dredge *Vulcan* in July, 1901. The cost of this work was $281.43.

Dredging at Dubuque Bridge.—Dredge *Geyser* was employed for eleven days in July, 1901, deepening the channel below the draw of the Illinois Central Railway bridge at Dubuque (mile 265). The amount of sand removed was, approximately, 11,600 cubic yards, at a cost of $368.53. The average cost per yard dredged was about 3 cents, exclusive of plant charge.

Removing wrecks in vicinity of Quincy.—Dredge *Phoenix*, in July, 1901, removed three wrecks from the channel, viz, a large barge in the crossing at Island 436 (mile 532); United States barge No. 156, sunk on snag at South River (mile 528), and the *Satellite*, above Quincy Bridge (mile 521). The cost of removing these wrecks was $638.41.

Removing rock ledge at Fort Madison.—This work was commenced July 19, 1901, by *Drill Boat No. 6*, and she continued drilling and blasting until September 1. Dredge *Ajax* was employed from August 28 to September 17, 1901, in removing the broken rock. The obstructing ledge (mile 463) was 790 feet long and averaged 60 feet in width, being from 0.4 to 2.9 feet above a 5-foot grade line. Drilling was carried down to a depth of 5½ feet at low water. The material found was hard rock, cemented gravel, and sand, with scattering bowlders lying on a bed of clay. My original estimate for this work, based on a survey made in November, 1896, called for the removal of 1,800 cubic yards of material at a cost of $5,072. The work was performed as projected, and resulted in the removal of 1,735 cubic yards of material, at a cost of $3,717.14, exclusive of plant charges. Average cost per cubic yard of rock removed, $2.14. The drill boat worked 364 hours, drilled 1,236 holes of an aggregate length of 4,488 feet, fired 1,153 holes, and used 2,363 pounds of dynamite. The area covered by the drill boat was 36,902 square feet. (The plant charge for this work is $1,562.26, which increases its cost to $5,279.40, and the average cost per cubic yard to $3.04.)

Field operations on above work, as well as that at Drew Chute and Burlington, were in charge of Mr. J. C. McElherne, assistant engineer.

Dredging Burlington Harbor.—Dredge *Ajax* was employed from September 18 to 30, 1901, in removing deposits from the steamboat landing at Burlington (mile 442). The dredging covered the area from lower side of Jefferson street to upper side of

Washington street, extending out to deep water, an average distance of 105 feet. The length of the cut was about 500 feet.

There were removed 6,169 cubic yards of sand and mud, at a cost, exclusive of plant charges, of $495.68, or 8 cents per cubic yard.

Dredging in Drew Chute.—In August, 1901, dredge *Ajax* removed a few bowlders from the channel a little below mouth of Henderson River (mile 437). She also removed Wing Dam 10 (mile 440, sheet 58), 350 feet in length, extending from the towhead abreast of Rush Island and encroaching upon the channel. In October the *Ajax* removed the highest point of a ledge which the *Mackenzie* struck (mile 437). This ledge is opposite Dam 13 (sheet 58) and in about the same locality as the rock excavation in 1887. In extent it is about 100 by 75 feet, and it should be entirely removed to a grade of 5 feet at low water. The cost of work mentioned above was $177.03.

Removing bowlders at Gregory.—Dredge *Phœnix*, in October, 1901, removed a large bowlder from the channel in front of Gregory (mile 495). This bowlder, which weighed 14 tons, had only 1.9 feet on it at low water, was very dangerous, and had been hit by several boats. Another large rock in the channel near the steamboat landing was also removed. The cost of this work was about $300.

RIVER NOTES.

In 1901 there was a fair boating stage during the entire season. Although the water during the latter part of August and in September was quite low, boats had no difficulty at any locality. In 1902 the river was rather lower than usual in the spring, but navigation was good. During May a considerable rise occurred, due to heavy rains in the North. The river subsided gradually in June, remaining, however, at a good stage at end of month.

Table of depths, in feet, on bars between St. Paul and mouth of Missouri River, from channel soundings made September and October, 1901.

[No reference is made to bars showing 4 feet and more at low water 1864.]

Distance from Omaha Bridge, St. Paul.	District and locality.	Soundings.	Stage.	Old or new bar.	Remarks.
	Omaha Bridge to Lake Pepin.				
Miles.					
1	Below Smith avenue	4.2	2.1	New	No improvements made.
19	Gray Cloud	5.8	2.1	Old	Rock.
20	Below Grey Cloud	5.6	2.1	...do	Do.
	Reeds Landing to Winona.				
82	Above head Crats Island	5.4	2.7	...do	Mackenzie got 5 at 1.5 stage.
85	Grand Encampment Island	6.1	2.8	...do	Mackenzie got 5.5 at 1.5 stage.
86	Beef Slough Boom	6.5	2.8	...do	
87	Beef River (above)	5	2.8	...do	
87	Beef River (below)	5.8	2.6	...do	
93	Above West Newton	6.2	2.4	...do	Mackenzie got 5 at 1.5 stage.
95	Below West Newton	5.5	2.5	...do	Probably out of channel.
96	Head Buffalo Chute	5.2	2.6	...do	
97	Zumbro River	5.2	2.2	...do	
99	Below Minneiska	5.2	2.2	...do	
103	Above Chimney Rock	5.6	1.7	...do	Probably not the best water.
107	Rollingstone (Island 58)	4	1.3	...do	
110	Head Betsy Slough	6	2.2	New	
114	Argo Island	5	2.8	Old	Probably out of channel.
	Winona to La Crosse.				
120	Above Minneowa	5.4	2.7	New	
122	Homer Chute (foot)	5.6	2.7	...do	Mackenzie 7 at 3 stage.
124	Mount Trempealeau	5.8	2.6	Old	
125	Above La Moille	5.4	2.6	...do	Mackenzie 7 at 2.6 stage.
180	Richmond Island	6	2.4	...do	
130	Above Queens Bluff	5.4	2.3	...do	
135	Opposite Dakota	6	2.2	...do	
136	Below Dakota	5.4	2.2	...do	
138	Opposite Dresbach Island	5.9	2.3	...do	
140	Above Minnesota Island	5.5	2.5	...do	Possibly an error.
148	Above La Crosse (Bates Island)	5.8	2.7	...do	
144	Opposite La Crosse	5.8	2.7	...do	

Table of depths, in feet, on bars between St. Paul and mouth of Missouri River, from channel soundings made September and October, 1901—Continued.

Distance from Omaha Bridge, St. Paul.	District and locality.	Soundings.	Stage.	Old or new bar.	Remarks.
	La Crosse to Wisconsin River.				
Miles.					
152	Above Brownsville	6.1	3.1	Old	
171	Battle Island (137)	6.5	3	...do	
173	Above De Soto	5.5	3	...do	Mackenzie 4.5 at 1.6 stage.
177	Below De Soto (Island 145)	5.5	2.8	New	Possibly an error.
178	Above Lansing	6	2.8	...do	Out of channel. Mackenzie got 7.5 at 1.6 stage.
187	Head Crooked Slough	6.1	2.6	Old	
189	In Crooked Slough (Swift Slough).	5.2	2.6	...do	
191	Foot Crooked Slough	5.6	2.6	New	Mackenzie 5.5 at 1.6 stage.
194	Below Lynxville	5.7	2.6	Old	
	Wisconsin River to Bellevue.				
216	Opposite Wyalusing	5.4	1.7	...do	
227	Below Glenhaven (Ferry Slough)	5.1	1.4	...do	
229	Below Glenhaven	5	1.4	...do	In three places, shoal
240	Above Buena Vista	5	1.4	New	
241	Bunker Chute	5.3	1.4	Old	
246	Hurricane Island	5	2.4	...do	
250	Above Frenchtown	5.7	2.4	New	
253	Below Spechts Ferry	5	2.3	Old	Long shoal bar.
254	Parsons bar	4.6	2.3	...do	Probably out of channel.
255	Below Parsons bar	6	2.2	New	
260	Sinope (Island 219)	4.8	2.2	Old	Mackenzie; probably out of channel.
261	Above Eagle Point (Kimbels)	5.7	2.2	...do	
270	Head Nine-mile Island	4.7	2.2	...do	
276	Upper Deadmans bar	4	1.7	...do	
277	Lower Deadmans bar	5.1	2.3	...do	
281	Stone Slough	4.5	2.4	...do	
285	Foot Bellevue Slough	4.3	2.3	...do	Mackenzie 4 at 1.5 stage.
	Bellevue to Rock Island.				
290	Below Bellevue	5	2.3	New	Improved 1901.
298	Sand Prairie	4.9	2	Old	
304	Santa Fe	4.5	1.9	...do	Mackenzie 5 at 1.7 stage.
308	Opposite Savanna	4.5	1.7	New	Do.
315	Above Elk River Slough	5.4	1.7	...do	
319	Pomme de Terre (Elk River)	4.8	1.7	...do	
320	Opposite Island 283	4	1.7	...do	In October, Mackenzie 5.5 at 1.7.
324	Above Lyons	5.3	1.8	Old	
332	Below Albany	5.5	1.7	...do	
333	Above Camanche	3.9	1.7	...do	
336	Barnes Crossing	5	1.6	New	
341	Above Cordova	5	1.2	Old	
	Rock Island to Burlington.				
367	Rockingham	5	1.5	...do	Rock. Not in improved channel
369	Foot of Horse Island	4.4	1.5	...do	Improvement in 1901.
370	Above Linwood	5.	1.5	New	Do.
371	Opposite Linwood	4.5	1.5	...do	Do.
371	Dodges	5.4	1.5	Old	Probably not the best water.
374	Below Buffalo (Island 322)	4.9	1.5	New	Mackenzie 4.5 at 0.5 stage.
376	Above Montpelier	4.7	1.5	...do	Do.
378	Below Montpelier (Vela Chute)	4.5	1.5	Old	Partial improvement.
380	Pine River	5.2	1.5	...do	
381	Below Fairport	5.1	1.5	...do	Improved. Good at low water.
388	Foot of Hershey Chute	5.4	1.5	...do	Good.
401	Above Port Louisa	4.	1	New	Probably sand from Illinois Chute Works.
407	Turkey Island	4.9	1	Old	Good at low water.
423	Above Johnsons Island	4.	.8	New	Mackenzie 4 at 0.5 stage.
424	Johnsons Island	4.1	.8	...do	
439	Foot Otter Island	4.1	.8	Old	Do.
	Burlington to Hannibal.				
451	Foot of Shokokon Slough	4.7	.8	...do	Good at low water. Mackenzie 5 at 0.5 stage.
460	Appanoose	4.4	.9	...do	Long shoal.
467	Devils Island	3.5	.7	New	Mackenzie 4 at 0.8 stage.
527	Fabius Island	5.7	1.8	Old	

Table of depths, in feet, on bars between St. Paul and mouth of Missouri River, from channel soundings made September and October, 1901—Continued.

Distance from Omaha Bridge, St. Paul.	District and locality.	Soundings.	Stage.	Old or new bar.	Remarks.
	Burlington to Hannibal—Cont'd.				
Miles.					
530	Marion City	4.7	1.7	Old...	Mackenzie 5 at 1.4 stage; 6.5 at 2.3 stage.
532	Beebe Island (436)	4.8	1.7	New..	
533	Whitney (Upper)	5.6	1.7	Old...	
535	Whitney (Lower)	4.5	1.7	...do..	Probably out of channel.
536	Armstrong Island	5	1.7	...do..	
	Hannibal to Missouri River.				
547	Saverton	5.4	1.7	New..	
547	Saverton (below)	5	1.7	Old...	
552	Head Gilberts Chute	5.1	1.6	New..	Mackenzie 5 at 1.4 stage.
555	Foot Gilberts Island	4.5	1.6	Old...	Mackenzie 4.5 at 1.3 stage.
557	Above Mundy's Landing	5.4	1.6	...do..	
557	Below Mundy's Landing	4.5	1.6	...do..	Mackenzie 5 at 1.3 stage.
558	Blackbird Island	5.4	1.5	...do..	
565	Angle Island (opposite)	4.8	1.5	New..	Do.
569	Below Louisiana Bridge	4.7	1.5	Old...	Do.
571	Kriders Bend	3.4	1.5	...do..	Very shoal all the season.
582	Amaranth Island	4.6	1.2	...do..	
583	Mulherns Field	4	1.2	...do..	Do.
586	McCoys Island	5	1.2	...do..	
587	Above Grimes Island	4.3	1.2	...do..	
608	Sandy Island	4.2	1.2	...do..	
612	Cap au Gris	4.9	1.2	...do..	Mackenzie 5.5 at 1.3 stage.
622	Head Two Branch Chute	5.5	2.1	...do..	Out of channel. Mackenzie 6 at 1.3 stage.
624	Below Two Branch Island	5.8	2.1	...do..	
635	Opposite Grafton	4.8	2.8	...do..	Mackenzie 4 at 1.3 stage.
638	Babbs Hollow	5	2.4	New..	Out of channel. Mackenzie 5 at 0.8 stage.
641	Above Portage	6.1	2.4	Old...	Out of channel. Mackenzie 6.5 at 0.8 stage,

Summary of expenditures.

Snag boat *Col. A. Mackenzie*, operating	$17,281.02
Dredging at draw of Dubuque Bridge	368.53
Removing obstructing dam at Teepeeota Point	281.43
Removing wrecks of *Satellite* and two barges	638.41
Removing rock ledge at Fort Madison	3,540.11
Removing rock at Drew Chute and Dam No. 10	177.03
Removing crib at La Crosse	149.05
Dredging at Burlington Harbor	495.68
Superintendence and office expenses	2,068.74
Total	25,000.00

Very respectfully, your obedient servant,

C. W. DURHAM, *Assistant Engineer.*

Maj. C. McD. TOWNSEND,
Corps of Engineers.

Y 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN MOUTH OF MISSOURI RIVER AND ST. PAUL.

The work performed under this appropriation consists chiefly in the permanent improvement of through navigation, but improvements at harbors and other localities are frequently made under allotments as provided in the various acts of Congress.

The original condition of the channel between the Missouri River and St. Paul was such that at low stages the larger boats were unable to proceed farther up the river than La Crosse or Winona, while at extreme low water navigation was impeded at points much lower. The original project for improvement, which has undergone no material change, was adopted in 1878, and contemplates the closure of chutes, revetment of caving banks, and contraction of the channel by wing dams, so as to obtain a channel of a depth of 4½ feet at low water, to be eventually increased to 6 feet. At the close of the fiscal year ending June 30, 1902, there had been expended $10,147,801.60, which has resulted in such an improved condition of the channel as to permit the passage of the largest boats at very low stages through to St. Paul. On July 1, 1901, there was unexpended $208,988.12, and during the past year, for the improvement of through navigation, work of dam construction, shore protection, dredging, removal of rock, etc., has been carried on by hired labor and use of Government plant between Wabasha (81 miles from St. Paul) and Bellevue (mile 288); at Rock Island Rapids (miles 349-363) and between Hannibal (mile 541) and the Missouri River (mile 658); under contract between Cassville (mile 237) and Le Claire (mile 349), and between Rock Island (mile 363) and New Boston (mile 412).

The balance available July 1, 1902, will be applied by hired labor at such points as may seem most in need of improvement.

St. Paul to Winona.—By hired labor and use of Government plant work was carried on during summer of 1901 in vicinity of Teepeeota Point (miles, 84–85)), where 4 wing dams and 1 closing dam were built and 1 wing dam was lengthened.

Winona to Wisconsin River.—The only work carried on in this district was performed by hired labor during September, and October, 1901, and consisted in the construction of 4 short wing dams from the east side of Barrons Island (mile 144), opposite La Crosse. These dams were included in the original project for the improvement of La Crosse Harbor.

Cassville to Dubuque.—In this section work was done during the months of July and August, 1901, under contract with John Pickley, dated July 21, 1899. In vicinity of Finleys Landing (miles 246–251) 5 wing dams, begun in 1900, were completed, as was also shore protection on Hurricane Island. On Island 208, 5,200 linear feet of shore protection was built, and on Island 209, 630 feet. In vicinity of Dubuque (miles 259-264) repairs were made to 1 closing dam, and 1 wing dam. By hired labor, U. S. hydraulic dredge *Geyser* worked about three weeks in deepening the channel through the bar below the draw of the Illinois Central Railway bridge.

Dubuque to Le Claire.—In this section, under contract with John Pickley, dated July 21, 1899, work was carried on from September 3 to November 14, 1901, at Nine-mile Island (mile 270), where some repairs were made to shore protection; near foot of Bellevue Slough (miles 283–286), where a trailing dam was built and 3 closing dams repaired, and below Bellevue (mile 290), where 3 wing dams and 400 linear feet of shore protection were constructed.

Rock Island Rapids.—In July, 1901, the north side of Moline Crossing (mile 359) was swept over and a considerable amount of loose rock was removed from the channel and used in repairing the foundation of Guide Pier No. 20. The buoys used on the rapids during season of navigation were taken up and stored for the winter in November, 1901, and were reset in April, 1902.

Rock Island to New Boston.—In this section work was carried on in 1901 under contract with Fetter & Crosby, approved August 26, 1900. In vicinity of Horse Island (miles 367–370), 15 wing dams, aggregating 8,830 feet in length, were built, and 1 closing dam, 980 feet in length. During May and June, 1902, 8,377.5 cubic yards of dredged material, consisting of gravel and bowlders, was placed in foundation of Dam 29, from Illinois shore nearly opposite head of Horse Island.

Hannibal to Missouri River.—Operations in this division were carried on by hired labor and Government plant from July 15 to October 12, 1901. At Maple Island (mile 656) 3 wing dams were repaired; at Portage (mile 642) the causeway was repaired; at Cincinnati Landing (mile 554), Mundys Landing (mile 557), and Hickory Chute (mile 565) the shore protections previously built to an average height of 6 feet above low water were carried to top of bank and completed.

The details of the above-mentioned improvements are given in the appended reports of assistants in local charge.

Commercial statistics accompany my report on operating snag boats and dredge boats on the Upper Mississippi River.

Summary of expenditures for calendar year ending December 31, 1901, for improving Mississippi River from Missouri River to St. Paul.

St. Paul to Winona	$16,654.35
Winona to La Crosse	9,915.58
Winona to Wisconsin River	8,381.00
Wisconsin River to Bellevue	4,261.59
Cassville to Dubuque	14,061.09
Dubuque to Le Claire	33,575.50
Rock Island Rapids	7,096.37
Rock Island to New Boston	30,750.47
Burlington to Montrose	2,274.36
Quincy to Saverton	14,145.64
Hannibal to Missouri River	14,579.77
Snag boats and dredges	1,574.22
Survey and gauges	2,697.07
Construction, care, and repair of plant	11,795.40
Channel at Clinton	506.92
Flint Creek to Iowa River Levee	44.41
Warsaw to Quincy Levee	125.00
Bar at Quincy	293.25
Total	172,731.99

NOTE.—In above statement retained percentages on contracts, December 31, 1900, have been deducted, having been included in last year's report.

Net expenditures on various sections of the river, harbors, levees, etc., between Minneapolis and the Missouri River from commencement of improvement to June 30, 1902.

Locality.	Distance.	Amount.	Per mile.
	Miles.		
St. Paul to Minneapolis	....	$59,113.46	....
St. Paul to Prescott	30	667,154.00	$22,238
Prescott to Lake Pepin	26	338,219.92	13,008
Foot of Lake Pepin to Alma	11	428,226.64	38,929
Alma to Winona Bridge (C. & N. W.)	28	624,674.00	22,309
Winona Bridge to La Crosse Bridge (C., M. & St. P.)	28	578,120.44	20,647

Net expenditures on various sections of the river, harbors, levees, etc., between Minneapolis and the Missouri River from commencement of improvement to June 30, 1901—Cont'd.

Locality.	Distance.	Amount.	Per mile.
	Miles.		
La Crosse Bridge to McGregor Bridge	64	$650,632.81	$10,168
McGregor Bridge to Dubuque Bridge (Illinois Central)	57	304,920.95	5,348
Dubuque Bridge to Clinton Bridge (C. & N. W.)	62	343,293.03	5,537
Clinton Bridge to Le Claire	21	39,830.24	1,897
Rock Island Rapids (see note)	14	566,522.27	40,466
Rock Island Bridge to Keithsburg Bridge	55	302,486.76	5,500
Keithsburg Bridge to Nashville	59	862,043.46	14,611
Keokuk Bridge to Quincy Bridge	37	549,244.66	14,844
Quincy Bridge to Clarksville	56	884,730.76	15,799
Clarksville to Cap au Gris	37	852,805.78	23,049
Cap au Gris to Illinois River	24	394,553.08	16,450
Illinois River to Missouri River	23	431,446.95	18,750
West St. Paul	....	15,000.00	....
Harbor in Lake Pepin:			
At Bay City	....	1,000.00	....
At Lake City (see note)	....	21,290.62	....
At Stockholm (see note)	....	500.00	....
At Kings Coulee	....	30,000.00	....
Harbor at La Crosse (see note)	....	5,000.00	....
Vicinity of Prairie du Chien	....	30,000.00	....
Harbors at Dubuque and East Dubuque (see note)	....	25,000.00	....
Ice harbor at Dubuque (see note)	....	10,000.00	....
Channel and harbor at Clinton	....	22,071.15	....
Harbor at Port Byron	....	5,000.00	....
Harbor at Rock Island (see note)	....	10,000.00	....
Harbor at Muscatine (see note)	....	15,000.00	....
Harbor at Burlington (see note)	....	5,000.00	....
Harbor at Montrose (see note)	....	2,000.00	....
Harbor at Quincy (see note)	....	11,526.16	....
Harbor at Clarksville	....	15,000.00	....
Quincy Bay (see note)	....	82,829.65	....
Hamburg Bay	....	10,000.00	....
Flint Creek-Iowa River Levee	....	296,956.73	....
Warsaw-Quincy Levee	....	91,840.81	....
Sny Island Levee	....	106,728.99	....
Surveys, gauges, and meter work	....	218,608.02	....
Snag and dredge boats and wrecking	....	82,093.35	....
Practical test of Adams Flume (see note)	....	27,176.83	....
Plant at estimate value	....	135,160.08	....
Total	....	10,147,801.60	....

NOTE.—Amounts additional to those given in above have been expended under special appropriations, as follows: Harbor at Stockholm, $25,000; Lake City Harbor, $20,000; La Crosse Harbor, $12,000; Dubuque and East Dubuque harbors, $41,000; ice harbor at Dubuque, $35,500; Guttenberg channel, $8,000; Rock Island Harbor, $12,000; Andaluria channel, $6,000; Muscatine Harbor, $20,000; Fort Madison Harbor, $24,100; Burlington channel and harbor, $30,000; Quincy Harbor, $15,000; Quincy Bay, $45,000; Hannibal channel and harbor, $45,000; Louisiana Harbor, $10,000; Alton Harbor, $108,000; vicinity of Alexandria, $16,000; La Crosse to Root River, $12,500; Rock Island Rapids, $1,166,650; Des Moines Rapids, $4,574,950; dry dock at Des Moines Rapids Canal, $125,000; total, $6,351,700.

General statement showing net expenditures from the commencement of improvement, in 1878, to June 30, 1902, under various heads of appropriations.

St. Paul to Des Moines Rapids	$1,597,500.00
Minneapolis to Des Moines Rapids	1,100,000.00
Des Moines Rapids to Illinois River	1,330,000.00
Ohio River to Minneapolis, applied to "Between mouth of Missouri River and Minneapolis"	3,000,000.01
Ohio River to St. Paul, applied to "Between Missouri River and St. Paul"	3,170,179.26
	10,197,679.27
Less amount transferred to work at Lock and Dam No. 2, Mississippi River, between Minneapolis and St. Paul, act of August 18, 1894	49,877.67
Total net expenditures	10,147,801.60
Balance July 1, 1902, Missouri River to St. Paul	459,820.75
Total appropriated	10,607,622.35

Money statement.

July 1, 1901, balance unexpended	$208,988.12
Amount appropriated by river and harbor act approved June 13, 1902.	400,000.00
	608,988.12
June 30, 1902, amount expended during fiscal year	149,167.37
July 1, 1902, balance unexpended	459,820.75

Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$1,000,000.00	
For maintenance of improvement	30,000.00	
		1,030,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

ABSTRACT OF APPROPRIATIONS.

St Paul to Des Moines Rapids:	
By act approved—	
June 18, 1878	$250,000.00
March 3, 1879	100,000.00
June 14, 1880	150,000.00
March 3, 1881	200,000.00
By act passed August 2, 1882	250,000.00
By act approved—	
July 5, 1884 (general improvement)	250,000.00
July 5, 1884 (applied to harbor, Lake City)	15,000.00
August 5, 1886	382,500.00
Minneapolis to Des Moines Rapids:	
By act of August 11, 1888	600,000.00
By act of September 19, 1890	500,000.00
Des Moines Rapids to Illinois River:	
By act approved—	
June 18, 1878	100,000.00
March 3, 1879	40,000.00
June 14, 1880	100,000.00
March 3, 1881	175,000.00
By act passed August 2, 1882	200,000.00
By act approved—	
July 5, 1884	200,000.00
August 5, 1886	150,000.00
By act of August 11, 1888	200,000.00
By act of September 19, 1890	165,000.00
Ohio River to Minneapolis, applied to "Between Missouri River and Minneapolis:"	
By act approved—	
July 13, 1892	600,000.00
March 3, 1893 (sundry civil)	866,666.67
August 18, 1894 (sundry civil)	866,666.67
March 2, 1895 (sundry civil)	866,666.67
Ohio River to St. Paul, applied to "Between Missouri River and St. Paul:"	
By act of June 3, 1896	200,000.00
By act of June 4, 1897 (sundry civil)	826,666.67
By act of July 19, 1897 (deficiency)	200,000.00
By act of July 1, 1898 (sundry civil)	826,666.67
By act of March 3, 1899 (sundry civil)	826,666.67
By act of June 6, 1900 (allotment)	150,000.00

Missouri River to St. Paul:	
By act approved June 13, 1902	$400,000.00
Total	10,657,500.02
Less amount transferred to work at Lock and Dam No. 2, Mississippi River, between Minneapolis and St. Paul (act August 18, 1894)	49,877.67
	10,607,622.35

Comparative cost of material, 1901.

[Per cubic yard.]

Locality.	Rock.		Brush.	
	In place.	On United States barges.	In place.	On United States barges.
Alma to Fountain City				$0.125
Fountain City		$0.50		
Winona to La Crosse	$1.00		$0.30	
Dakota		[a] .40		
La Crosse to Root River				.17
Cassville to Dubuque	.90		.20	
Dubuque to Le Claire	.94		.25	
Rock Island to New Boston	.89		.26	
Burlington to Montrose	.85		.30	
Quincy to Saverton	.96		.26	
Hannibal		.53		
Louisiana		.62		
Louisiana, vicinity of				.16
Hop Hollow		.55		

[a] Sand rock.

NOTE.—The price per cubic yard of hard rock delivered on barges varied from 50 cents at Fountain City to 62 cents at Hannibal. The average cost of this rock during the season was 55 cents.

The price per cubic yard of brush varied from 12¼ cents between Alma and Fountain City to 17 cents between La Crosse and Root River. The average cost of brush during the season was 14 cents.

United States improvement, Upper Mississippi River, St. Paul to Missouri River (Rock Island Rapids not included), 1878–1901.

[Including some desultory work done prior to 1878.]

Total length of dams (1,081,836 feet)	miles..	204.9
Total length of shore protections (940,053 feet)	do....	178
Dams:		
Total rock	cubic yards..	3,089,029.8
Total brush	do....	4,716,211.4
Total material	do....	7,805,241.2
Average per linear foot, rock	do....	2.86
Average per linear foot, brush	do....	4.36
Average per linear foot, material	do....	7.22
Shore protection:		
Total rock	do....	1,622,132.1
Total brush	do....	1,436,525.1
Total material	do....	3,058,657.2
Average per linear foot, rock	do....	1.73
Average per linear foot, brush	do....	1.55
Average per linear foot, material	do....	3.28
Grand total of material used	do....	10,863,898.4

Subsistence statement, season 1901.

District.	Number days subsisted.	Cost.		Average per day.	
		Without cooks.	With cooks.	Without cooks.	With cooks.
St. Paul to Winona	3,266	$1,227.04	$1,714.05	$0.375	$0.525
Rock Island Rapids	2,067	621.09	811.42	.300	.393
Fort Madison and Burlington	1,476	456.00	654.92	.309	.444
Illinois and Mississippi Canal	918	265.09	351.26	.289	.382
Galena River	1,577	408.93	727.60	.259	.461
Des Moines Rapids Canal, etc	4,951	1,326.89	2,079.22	.268	.420
Hannibal to Missouri River	2,613	861.29	1,157.95	.329	.443
Snag boat Col. A. Mackenzie	5,222	1,586.10	2,261.10	.303	.433
Total	22,090	6,752.43	9,757.52	.306	.442

Fuel statement, season 1901.

District.	Coal (tons).	Average cost per ton.	Total cost.	Tow, mileage, and average cost of fuel.				Name of boat.	Hours per day.
				Days.	Per day.	Miles.	Per mile.		
St. Paul to Winona	415.4	$3.43	$1,425.11	103	$13.84	4,212	$0.34	Fury	12
Winona to Wisconsin River.	104	3.35	348.50	54	6.45	1,735	.20	Elsie	12
	577.4	3.35	1,934.32	149	12.98	......	......	Dredge 203 [a]	8
Dubuque dredging	62.2	2.60	161.72	14	11.55	......	......	Dredge Geyser [a]	16
Galena River dredging.	277.2	2.63	730.19	97	7.53	......	......	do	8
	81.5	2.63	214.82	113	1.90	1,665	.13	Stella	12
Rock Island Rapids, Illinois and Mississippi Canal, Fort Madison, and Burlington.	273.3	1.99	542.65	192	2.82	5,994	.09	Ruth	12
	138.7	1.99	275.51	150	1.84	......	......	Dredge Ajax [b]	8
	53.5	2.06	109.97	56	1.96	......	......	Drill boat No. 6	8
Des Moines Rapids Canal.	976.6	1.90	1,855.62	52	9.68	......	......	Dredge Phoenix and Lucia. [b]	16
	......	......	......	95	14.23	......	......	Dredge Phoenix and Vixen. [b]	16
Snag boat	1,245	2.37	2,953.40	200	14.92	6,618	.446	Mackenzie	12
Total	4,204.8	2.51	10,551.81	......	......	......	......	......	......

[a] Pump dredge.

[b] Dipper dredge.

Distance, low-water elevations, fall, slope, and high and low water stages during season of navigation, Upper Mississippi River, St. Paul, Minn., to St. Louis, Mo.

Locality.	Distance from St. Paul.	Elevation of datum low water of 1864.	Fall.	Slope per mile.	Lowest water stages 1878–1901.	Highest water stages 1878–1901.
	Miles.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
St. Paul (Omaha bridge)	0	706.02	....	....	....	....
St. Paul (Jackson street)	2.2	705.11	....	....	−0.3	19.1
Newport	10.3	700.15	5.87	0.570	....	....
Hastings	27.2	690.79	9.36	.554	− .5	18
Prescott	29.7	689.86	.93	.372	− .7	....
Diamond Bluff	40.9	686.71	3.15	.281	....	....
Trenton	46.6	685.69	1.02	.179	....	....
Red Wing	50	685.47	.22	.065	− .3	15.3
Wacouta	56.1	685.03	.44	.072	....	....
Lake City	68	684.89	.14	.010	....	14.9
North Pepin	73.5	684.85	.04	.007	....	....
Reeds Landing	77.3	684.64	.21	.055	− .4	14.8
Wabasha	80.6	681.83	2.81	.851	....	16.3
Alma	88	676.26	5.57	.753	....	16.3
Minneiska	98.4	671.01	5.25	.505	....	15.1
Mount Vernon	100	669.75	1.26	.788	....	....
Fountain City	108.2	665.42	4.33	.528	....	15.3
Winona	115.9	660.34	5.08	.660	.2	17
Homer	121	659.08	1.26	.247	....	....
Trempealeau	126.9	655.66	3.42	.580	....	....
Richmond	129.8	653.66	2	.690	....	....

Distance, low-water elevations, fall, slope, and high and low water stages during season of navigation, Upper Mississippi River, St. Paul, Minn., to St. Louis, Mo.—Continued.

Locality.	Distance from St. Paul.	Elevation of datum low water of 1864.	Fall.	Slope per mile.	Lowest water stages 1878–1901.	Highest water stages 1878–1901.
	Miles.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Dresbach	186.5	650.97	2.69	.401	....	17
La Crosse wagon bridge	144.2	646.48	4.49	.583	0.2	16
Brownsville	152.6	642.61	3.87	.461	....	16.5
Warners Landing	158.7	638.52	4.09	.670	....	....
Genoa	162.3	637	1.52	.422	....	19
Victory	169.3	635.51	1.49	.213	....	18.7
De Soto	174.4	633.96	1.55	.304	....	....
Lansing	178.8	632.34	1.62	.368	....	19.6
Heytmans (below)	187.3	630.80	1.54	.181	....	....
Lynxville	191.5	628.79	2.01	.479	....	20.9
Johnsonport	202	626.10	2.69	.256	....	....
North McGregor Bridge	208	625.32	.78	.130	.3	21.5
Wisconsin River	212.3	624.86	.46	.107	....	....
Clayton	218.8	622.76	2.10	.323	....	21
Glenhaven	225.6	620.79	1.97	.290	....	19.9
Cassville	236.5	615.88	4.91	.450	....	21.6
Waupeton	244	613.26	2.62	.349	....	....
Spechts Ferry	251.8	610.29	2.97	.381	....	21.3
Dubuque	264.8	605.60	4.69	.361	.0	21.7
Bellevue	288	598.72	6.88	.297	....	20.5
Savanna	307.3	592.72	6	.311	....	19.8
Sabula	309.1	591.82	.90	.500	.2	19.5
Lyons Bridge	324.7	587.08	4.74	.304	....	20.4
Clinton	326.8	586.43	.65	.310	.2	20.5
Albany	331.2	585.42	1.01	.230	....	19.9
Cordova	342	583.21	2.21	.205	....	17.4
Le Claire	348.1	583.11	.10	.016	....	13.7
Hampton	353.1	575.58	7.53	1.506	....	14.8
Rock Island Bridge	362.8	562.37	13.21	1.362	.0	19.4
Buffalo	372	558.97	3.40	.370	....	....
Montpelier	376.6	557.10	1.87	.407	....	....
Fairport	382	554.79	2.31	.428	....	18.6
Muscatine	390	551.28	3.51	.439	− .5	17.4
Port Louisa	403.4	546.98	4.30	.321	....	15.5
New Boston	411.5	544.37	2.61	.322	....	16.2
Keithsburg	417.1	543.03	1.34	.240	− .3	14.9
Oquawka	429.2	537.03	6	.496	....	16
Burlington	441.6	531.25	5.78	.466	− .2	17.6
Dallas City	455.2	525.67	5.58	.410	....	17.5
Fort Madison	462.7	522.66	3.01	.401	− .3	16.5
Nauvoo	469.9	520.46	2.20	.306	....	14
Montrose	472.3	520.44	.02	.008	....	12.6
Nashville	476	516.86	3.58	.970	.2	12
Keokuk	484	497.79	19.07	2.384	− .7	19.6
Warsaw	488	495.52	2.27	.567	....	19.3
Alexandria	488.6	495.21	.31	.516	....	18.7
Gregory (below and near)	495	492.29	2.92	.456	....	16.5
Canton	506	488.42	3.87	.352	....	16.6
La Grange	512.1	484.99	3.43	.562	....	16.8
Quincy	521	478.25	6.74	.757	− .3	19.8
Hannibal Bridge	539.1	469.52	8.73	.482	− .2	21.8
Saverton	546.6	465.95	3.57	.476	....	....
Mundys Landing	556.7	462.51	3.44	.341	....	....
Louisiana	567.7	456.77	5.74	.522	.0	19.5
Clarksville	577.4	453.42	3.35	.345	....	17.3
Hamburg	592.7	446.37	7.05	.461	....	18.7
Stag Island (head)	600.7	442.70	3.67	.459	....	....
Hastings Landing	614.5	435.59	7.11	.515	....	21.4
Grafton	635.2	424.09	11.50	.556	.4	25.7
Elsah	639.5	423.50	.59	.137	....	23.8
Alton	651.1	418.37	5.13	.442	− .2	28.0
Maple Island	654.1	417.14	1.23	.410	....	....
Missouri River	658	414.75	2.39	.613	....	....
St. Louis (Eads Bridge)	676	400.24	16.90	.806	....	....

In 1850 high water at St. Paul was 19.7; at Newport, 18.4. In 1851, at Camanche (333 miles), 23.93; at Buffalo, 17.3. In 1869, at Trempealeau, 16. In 1870, at Red Wing, 16.6; at Wacouta, 16.6 (from Hayden's Geol. Survey 1877).

In 1844 high water at Elsah was 31.8; at Alton, 34.8. In 1851, at Keithsburg, 16.2; at Oquawka, 17.3; at Fort Madison, 21.4; at Montrose, 14.1; at Keokuk, 20.9; at Warsaw, 21.9; at La Grange, 19.5; at Quincy, 22.6; at Hannibal, 21.9; at Louisiana, 22.3; at Clarksville, 21.9, and at Alton, 30.7. In 1870, at Hastings, 18.7, and at Moline 15 (levels of C. W. Durham).

REPORT OF MR. J. D. DU SHANE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., January 21, 1902.

MAJOR: I have the honor to submit the following report of operations for improving the Mississippi River between St. Paul and Winona, the division in my local charge, for the calendar year ending December 31, 1901:

ST. PAUL TO WINONA.

The work of improvement was continued under project approved July 17, 1900, by hired labor and use of Government plant, towboat *Fury* doing the towing. Materials were purchased under emergency contracts, at the following prices per cubic yard, delivered on United States barges: For riprap rock, 50 cents; for brush, 12½ cents.

The beginning of work for the season was delayed until it could be determined during low water at what place the small amount of money available could be expended with greatest advantage to the interest of navigation. Work in the vicinity of Teepeeota Point (miles 84–85 from Omaha Bridge, St. Paul) was concluded to be the most necessary, and operations were begun there on July 15. The provisional project was modified, necessitating the removal of a part of Dam 48 (sheet 14 [a]), for which dredge *Vulcan* was used. The outer end of this dam was dredged off for a distance of 175 feet. Dam 54 (sheet 14), a closing dam, was built back of Island 32. Dams 55 and 56 were built from Island 31. Dams 57 and 58 were built from Island 32. Dam 4 was lengthened 290 feet. The shore protection on the head of Island 33, built in 1891, was repaired for a length of 600 feet where the head of the island had been cut away so as to leave the protection mostly in the river. This work was carried on with a small force. Operations were discontinued September 27. The fleet was laid up in Fountain City Bay. Towboat *Fury* was kept in commission until October 26, making surveys, etc. Further details of the work are given in the following list of works and financial statement:

List of works constructed and repaired and of materials used during season of 1901 between St. Paul and Winona.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 14:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Closing Dam 54	500	4	1,416.1	1,941.5
Wing Dam 55	300	4	626.5	1,229.6
Wing Dam 56	860	4	1,463.7	3,943.5
Wing Dam 57	765	4	898.8	2,141.3
Wing Dam 58	650	4	544.5	1,101.6
Wing Dam 4, extended	290	4	706.5	1,448.1
Shore protection, head of Island 33, repaired	....	10–12	808.2	804.2
Total	....	....	6,464.3	12,609.8

Financial statement for work of building dams and shore protections between St. Paul and Winona for the calendar year 1901.

Amount expended in the field (during progress of work)	$11,387.18
Add for general superintendence and office expenses	1,024.84
Add for use and deterioration of plant	3,016.28
Total	15,428.30

Material put in place:

Rock	cubic yards	6,464.3
Brush	do	12,609.8
Total		19,074.1

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[a] Sheet numbers are those of general maps, survey of 1878–79.

Average cost per cubic yard:

On barges	$0.252
For towing	.167
For putting in place	.178
For general superintendence and office expenses	.053
For plant	.158
Average cost per cubic yard in place	.808

At the beginning of the season 33 buoys were placed to mark the ends of dams near the channel on crossings. Thirty-one of these buoys were taken up at the end of the season and stored at Fountain City (mile 108), the other 2 having been lost.

During the season short surveys were made at Teepeeota (miles 84–85), West Newton (miles 93–94), Minneiska (miles 99–100), and at Wilds Landing (mile 112). In October channel soundings were made. From St. Paul to Lake Pepin (miles 1–55), where the work has been carried to a more nearly completed state than any other part of the river, these soundings showed a least depth of 6 feet at a 2-foot stage, or 4 feet below low water of 1864. During October a survey was made from St. Paul to Prescott (miles 1–30), covering 30 miles of river. The cost of this survey was $417.02. A survey was made at St. Paul during November and December, 1901, for the purpose of establishing harbor lines. The cost of this survey was $955.33. The maps of these surveys will be platted during the winter.

During the coming season additional work will be necessary at Teepeeota Point (mile 85) and below Wilds Landing (mile 113). Dams and shore protections should be built near Minneiska (mile 100) and below Fountain City (mile 109). Shore protections should be built on left bank below Alma (mile 90), on right bank above Zumbro River (mile 97), and on left bank opposite Island 55 (mile 106). Repairs to shore protections are needed below Reeds Landing (mile 79), head of Island 55 (mile 105), Island 59 (mile 108), Island 62 (mile 110), and in Argo Bend (mile 115). Repairs should be made to the harbor of refuge at Kings Coulee (mile 73), and the pier should be lengthened if practicable.

Very respectfully, your obedient servant,

J. D. Du Shane, *Assistant Engineer.*

Maj. C. McD. Townsend, *Corps of Engineers.*

REPORT OF MR. W. A. THOMPSON, ASSISTANT ENGINEER.

United States Engineer Office,
La Crosse, Wis., January 9, 1902.

Major: I have the honor to submit the following report of operations for improvement of the Mississippi River in the division in my local charge for the calendar year ending December 31, 1901.

WINONA TO LA CROSSE.

Under project approved April 7, 1899, and allotment of $40,000, a contract, dated July 21, 1899, was entered into with Albert Kirchner, of Fountain City, Wis., for the construction of rock and brush dams and shore protections, at $1 per cubic yard for rock and 30 cents per cubic yard for brush, in place. Under the terms of the contract it should have expired September 30, 1900, but owing to delays from various causes the contractor was unable to complete the work in the time specified, and consequently the time for completion was extended to June 1, 1901. Work under this contract was resumed May 1 and completed May 31, 1901.

The work performed during the season of 1901 was located between Minneowa and La Moille (miles 120–124), and was as follows: Wing Dam 83 (sheet 18), from west side of Island 74, commenced in 1900, completed; length 180 feet. There were built Wing Dam 84, from west side of Island 74, 640 feet below Wing Dam 83, length 210 feet; L Dam 85, extending from lower end of shore protection of Wing Dam 84 downstream 515 feet and then toward channel 160 feet, making a total length of 675 feet; Wing Dam 65 (sheet 19), extending from left bank 700 feet below old Wing Dam 35, length 260 feet; Wing Dam 66, extending from left bank 680 feet below Wing Dam 65, length 250 feet; Wing Dam 67, extending from left bank 665 feet above Wing Dam 68, length 240 feet, and Wing Dam 68, extending from left bank 850 feet above Island 78, length 370 feet. All of the above dams were built to a height of 4 feet above low water of 1864. Shore protection was laid on left bank, beginning 1,870 feet above Wing Dam 67 (sheet 19) and extending downstream a distance of 500 feet. The top of this shore protection is from 8 to 9 feet above low water, and the width of the mat is about 34 feet. Wing Dam 20 (sheet 19) was raised to 4 feet above low water and extended 97 feet. Wing Dam 21 was raised to 4 feet above low water a distance of 240 feet, beginning at shore end.

Total length of new dams built, 2,185 feet; total length of dams extended, 97 feet; total length of dams raised, 1,620 feet; total length of shore protection built, 500 feet.

Mr. S. L. Jamieson performed the duties of inspector in a satisfactory manner.

List of works constructed and repaired and of materials used during the season of 1901, between Winona and La Crosse, under contract with Albert Kirchner.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 18:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Wing Dam 83, completed		4	167.1	403.1
Wing Dam 84	210	4	419.8	1,042.6
Ell Dam 85	675	4	503.9	923.3
Sheet 19:				
Wing Dam 65	260	4	576.6	1,166.7
Wing Dam 66	250	4	761.2	1,643.4
Wing Dam 67	240	4	568	1,215.8
Wing Dam 68	370	4	691.7	1,716
Wing Dam 20, raised and extended	97	4	584.3	2,565.3
Wing Dam 21, raised (part)		4	98.4	513
Shore protection, left bank above Wing Dam 67	500	8-9	537.6	970.8
Total			4,908.6	12,160

Financial statement for work of building dams and shore protections between Winona and La Crosse, performed under contract with Albert Kirchner, during 1900 and 1901 (entire contract).

Amount paid contractor	$34,184.71
Cost of local inspection, etc	1,078.60
Add quota of general superintendence and office expenses	1,527.83
Add for use and deterioration of plant	57.92
Total	36,849.06

Material put in works:		
Rock	cubic yards	20,806.6
Brush	do	44,593.7
Total	do	65,400.3
Average cost per cubic yard in place		$0.564

WINONA TO WISCONSIN RIVER.

The only work performed by hired labor under allotment from the general appropriation was that of building four wing dams from the east side of Barrons Island (mile 144), opposite La Crosse. These dams were included in the original project for the improvement of La Crosse Harbor recommended by Lieut. Col. W. R. King, Corps of Engineers, under date of January 11, 1897.

The work was performed by hired labor and use of government plant, launch *Elsie* doing the towing. The material was purchased by agreement, at 17 cents per cubic yard for brush and 40 cents for sand rock, delivered on United States barges.

A few necessary repairs were made to the barges previous to commencement of operations.

Work was commenced September 6, 1901, and carried on with a small force and plant until October 31.

The location and description of each dam is approximately as follows: Wing Dam 47 (sheet 21), 400 feet in length, extends from east side of Barrons Island about 1,500 feet above La Crosse wagon bridge; Wing Dam 48, 550 feet in length, extends from east side of Barrons Island 500 feet below Wing Dam 47; Wing Dam 49, 140 feet in length, extends from east side of Barrons Island 500 feet above Wing Dam 47; Wing Dam 50, 365 feet in length, extends from east side of Barrons Island 470 feet below Wing Dam 48. All of these dams were built to a height of 3 feet above low water of 1864. Total length of dams built, 1,455 feet.

List of works constructed by hired labor and of material used during the season of 1901, between Winona and Wisconsin River.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 21:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Wing Dam 47	400	3	869.9	1,753.6
Wing Dam 48	550	3	1,271.3	2,386
Wing Dam 49	140	3	258.2	450
Wing Dam 50	365	3	881.7	1,559
Total	1,455		3,281.1	6,148.6

Financial statement for work between Winona and Wisconsin River, performed by hired labor during season of 1901.

Amount expended in field during calendar year 1901 (from distribution sheets)	$4,385.06
Add quota of general superintendence and office expenses	385.15
Add for use and deterioration of plant	1,544.94
Total	6,315.15
Material put in works:	
Rock ... cubic yards	3,281.1
Brush ... do	6,148.6
Total ... do	9,429.7
Average cost per cubic yard:	
On barges	$0.250
For towing	.112
For putting in place	.103
For general superintendence and office expenses	.041
For plant	.164
Average cost per cubic yard in place	.670

CONSTRUCTION OF AND REPAIRS TO PLANT.

By your letter of January 17, 1901, you authorized me to construct a quarterboat at Fountain City, to be used with the new hydraulic dredge No. 203. The materials were purchased in open market under existing regulations. Work of construction was commenced March 1, 1901, but discontinued March 9 on account of the failure of the river and harbor bill.

Work of repairs to plant at Fountain City boat yard was carried on at various times from March 1 to September 5. Light repairs were made to grasshopper No. 42, building boat No. 97, and 6 barges.

The work of completing construction of hydraulic dredge No. 203 was commenced April 19. The machinery was adjusted and all pipe connections made and tested. The boilers were inspected May 10 by the United States steamboat inspectors and found in first-class condition. Steam was raised and the machinery tested about May 15. It was found that the main engines caused such a vibration of the boat that additional bracing of the cabin and all the upper works would be necessary. This work was completed and the dredge placed in commission May 27.

Very respectfully, your obedient servant,

W. A. Thompson,
Assistant Engineer.

Maj. C. McD. Townsend,
Corps of Engineers

REPORT OF MR. S. EDWARDS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 20, 1902.

MAJOR: I have the honor to submit the following report of operations for improvement of the Mississippi River in the division in my local charge for the calendar year ending December 31, 1901.

CHANNEL AT CLINTON, IOWA.

Of the special allotment of $25,000 made by the sundry civil act of March 3, 1899, for improving and straightening the channel at and near Clinton, Iowa, there was available January 1, 1901 the sum of $3,485.87.

No construction work was performed during the year, but there was expended on care and repair of plant $507.02, leaving an available balance January 1, 1902, of $2,978.85.

REMOVING BAR AT DUBUQUE DRAWBRIDGE.

Early in June, 1901, an accumulation of sand in and below the draw of the railway bridge at Dubuque threatened to stop navigation, and two rafts were broken up on the obstruction. It was thought advisable to accelerate by dredging the improvement which it was proposed to make later by means of wing dams, and hydraulic dredge *Geyser* was put at work June 22 and continued operations until July 11. About 19,725 cubic yards of sand was dredged and delivered through pipe on the adjacent Illinois shore at East Dubuque. The cost of the work, a portion of which was paid for by the snag-boat appropriation, was, including plant and office charges, $1,444.12, or 7.3 cents per cubic yard.

CASSVILLE TO DUBUQUE.

Junior Engineer J. A. Macfie was inspector on this work, as well as on the improvements made during the season between Dubuque and Leclaire. He performed his duties very ably, and I give his reports in full below:

Under project approved April 7, 1899, and allotment of $40,000, a contract, dated July 21, 1899, was entered into with John Pickley, of Dubuque, Iowa, for the repair and construction of rock and brush dams and shore protections between Cassville and Dubuque, at 90 cents per cubic yard for rock and 20 cents per cubic yard for brush, in place. The contract time for completion having been extended from September 30, 1900, to September 30, 1901, operations, which had been discontinued October 16, 1900, on account of high water, were resumed July 1, 1901, and carried on until completion of the contract, August 31, 1901. From October 1, 1900, until completion of the contract, inspection expenses were paid by the contractor.

Vicinity of Finleys Landing (miles 246–251 from St. Paul).—On Hurricane Island (No. 202), 1,950 linear feet of shore protection, the apron of which was laid in 1900, was carried to top of bank. Wing dams 10, 11, 12, and 14 (sheet 35) from Iowa shore, commenced in 1900, were completed, and Wing Dam 16 was raised from 2 feet to 4 feet above low water. The entire south side of Island 208, 5,200 feet in length, was protected. At head of Island 209, 630 linear feet of shore protection was laid.

Vicinity of Dubuque (miles 259–264).—Small repairs were made to Closing Dam 2 (sheet 36) and Wing Dam 6.

List of works constructed and of materials used during season of 1901, under contract with John Pickley, between Cassville and Dubuque.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 34:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Shore protection, Island 202, raised	....	9	1,338.9	370.7
Sheet 35:				
Wing Dam 10, completed	....	4	471.8	720.9
Wing Dam 11, completed	....	4	178.6	312
Wing Dam 12, completed	....	4	185.4	835.6
Wing Dam 14, completed	....	4	98.4	....
Wing Dam 16, raised	....	4	647.5	1,025.6
Shore protection, Island 208	5,200	9.5	6,218.8	8,421.5
Shore protection, Island 209	630	10	696.5	1,189.2
Sheet 36:				
Closing Dam 2, repaired	....	4	542.4	799.6
Wing Dam 6, repaired	....	4–10	443.6	....
Total	....	....	10,815.9	13,125.1

Financial statement for work between Cassville and Dubuque performed under contract with John Pickley in 1900 and 1901 (entire contract).

Amount paid contractor	$29,812.97
Cost of local inspection, etc	1,017.46
Add quota of general superintendence and office expenses	1,646.92
Add for use and deterioration of plant	61.36
Total	32,538.71
Material put in works:	
Rock ....cubic yards..	25,104.7
Brush ....do.....	33,611.4
Total ....do.....	58,716.1
Average cost per cubic yard in place	$0.554

DUBUQUE TO LECLAIRE.

Under project of April 7, 1899, and allotment of $40,000, a contract dated July 21, 1899, was entered into with John Pickley for the repair and construction of rock and brush dams and shore protections, at 94 cents per cubic yard for rock and 25 cents per cubic yard for brush, in place. The original time of expiration of contract [illegible] September 30, 1900, but the limit was extended to September 1, 1901, and afterwards to December 1, 1901. Operations on this contract were commenced September 28, 1900, were discontinued November 12, 1900, resumed April 18, 1901, suspended June 27, again resumed September 3, and completed November 14, 1901. Inspection expenses in 1901 were paid by the contractor.

Vicinity of Dubuque (mile 264).—A wing dam, No. 6 (sheet 36), was built under the railway drawbridge. Its length is 675 feet, of which 450 feet has a crest elevation of 4 feet above low water, and 225 feet an apron course only.

At Nine-mile Island (mile 270).—Some repairs were made to the shore protection.

Vicinity of Bellevue Slough (miles 283–286).—Four closing dams (Nos. 12, 13, 14, and 15, sheet 39) were built; No. 12 between islands 245 and 246, No. 13 from Island 246 to the Illinois shore, Nos. 14 and 15 in Bellevue Slough. A trailing dam, No. 16, with two spurs, aggregating in length 1,700 feet, was built at foot of Island 243.

Opposite and below Bellevue (miles 287–290).—The causeway across Crooked Slough, opposite Bellevue, was completed. It is 230 feet long, 9 feet wide on top, and 8 feet above low water. Three wing dams (Nos. 17, 18, and 19, sheet 39), of an aggregate length of 1,925 feet, were built from the Iowa shore, and the shore protection on the Illinois shore opposite was extended 400 feet.

List of works constructed and of material used during season of 1901, under contract with John Pickley, between Dubuque and Leclaire.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
	Feet.	*Feet.*	*Cubic yds.*	*Cubic yds.*
Sheet 36:				
Wing Dam 6	450 225	4 10	5,094	8,077.3
Sheet 37:				
Shore protection, Island 232, repaired	....	....	396.9	422.5
Sheet 39:				
Causeway Dam 11	230	8	1,243.2	1,485.1
Closing Dam 12	520	4	2,165.4	3,719.8
Closing Dam 13	825	4	2,450.6	3,700.1
Closing Dam 14	690	3.5	1,595.5	2,424.3
Closing Dam 15	750	4	2,023.3	2,780.4
Trailing Dam 16	1,700	4	2,642.3	5.192.6
Wing Dam 17	575	0	458.3	984.6
Wing Dam 18	900	4	2,787.4	6,205.5
Wing Dam 19	450	4	858.6	1,634.1
Shore-protection, Illinois shore, extended	400	12	711.3	1,010.8
Total	....	....	22,426.8	37,637.1

Financial statement for work between Dubuque and Leclaire, performed under contract with John Pickley in 1900 and 1901 (entire contract).

Amount paid contractor		$32,824.09
Cost of local inspection, etc		427.23
Add quota of general superintendence and office expenses		2,865.73
Add for use and deterioration of plant		95.53
Total		36,212.58
Material put in works:		
Rock	cubic yards	24,931.6
Brush	do	41,553.5
Total	do	66,485.1
Average cost per cubic yard in place		$0.545

CARE AND REPAIR OF PLANT.

Repairs to the plant in the ice harbor at Dubuque were commenced February 18, 1901, but were discontinued March 15 owing to failure of the river and harbor bill. Hydraulic dredge *Geyser* and her pontons were put in good condition and employed at Dubuque and in the Galena River. Towboat *Coal Bluff* and her fleet remained in harbor in charge of watchmen during the entire season.

SURVEYS.

In June, 1901, a survey of the river from Eagle Point to Dubuque ice harbor was made, and in August, with the crew of the snag boat *Colonel A. Mackenzie*, surveys in vicinity of Bellevue Slough and below Bellevue were also made.

Very respectfully, your obedient servant,

S. EDWARDS, *Assistant Engineer.*

Maj. C. McD. TOWNSEND,
Corps of Engineers.

REPORT OF MR. J. C. M'ELHERNE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 23, 1902.

MAJOR: I have the honor to submit the following report of operations for the improvement of the Mississippi River, in the division in my local charge, for the calendar year ending December 31, 1901:

IMPROVING ROCK ISLAND RAPIDS.

The section of river comprising the Rock Island Rapids extends from the three hundred and forty-eighth mile to the three hundred and sixty-fourth mile from St. Paul.

The plant required for field service having been fully repaired, active operations with a very limited amount of funds were resumed on May 1, 1901.

Dams.—Wing Dam 6½ (sheet 47), from Iowa shore opposite Winnebago Island, had its paving repaired in places and was widened 10 feet throughout its entire length. Broken sections in roadway paving of Closing Dam No. 8, at Watertown, were mended, and its apron, to a width of 20 feet, was raised and strengthened. The north end of Wing Dam 9, at head of Duck Creek, had spots of paving reset, and was further reenforced. Trailing Dam 9½, on right side of the channel at Duck Creek Chain, was widened 5 feet and raised to its original height. Wing Dam 10, at foot of Duck Creek Chain, had former deposit of loose rock on top leveled down and trimmed into shape.

Dredging.—Dredge *Ajax*, with a single crew, from May 6 to June 10, 1901, removed a section 580 feet in length from outer end of Dam 16, at Cottonwood Chain, for the purpose of increasing the width of channel and moderating the velocity of the current in that locality. Owing to shoalness of water there, dredge work was suspended and the boats were transferred to right shoulder of Campbells Chain, where, from central part, it took out, between June 11 and 17, the large quantity of material blasted in 1900. From July 18 to 25 the high lumpy patch in north side of Moline Crossing below Buoy 23 was swept over, and a considerable number of loose rocks, large and small, were found and gathered up. Immediately afterwards the dredge was sent elsewhere for service. All the material obtained was utilized in various dams in the vicinity and in one guide pier.

Guide piers.—The foundation of Guide Pier 20, at lower end of Duck Creek Chain, was widened and raised on channel side where the rock had been much washed away by the action of ice gorges and floods.

The season's work having been completed on November 5, the remainder of the plant, idle in Moline Pool, was towed into the Illinois and Mississippi Canal and laid up in harbor for the winter.

Details of operations, season of 1901.

Towboat *Ruth:*	
Hours in use under steam	863
Miles run light	1,507
Miles run towing	1,303
Miles run, total	2,810
Dredge *Ajax:*	
Hours worked	544
Hours lost owing to accidents	0
Cubic yards loose rock dredged and removed	5,780

Summary of total amounts of material.

Solid cubic yards of rock dredged and removed only	1,000
Cubic yards of loose rock and bowlders dredged and removed	5,780

Cost of rock excavation, including charge for use and deterioration of plant.

Designation.	Rock excavated (solid cubic yards).	Total cost.	Average cost per solid cubic yard.
Right shoulder of Campbells Chain, dredged only	1,000	$1,740	$1.74

NOTE.—The material mentioned at right-shoulder of Campbells Chain as having been "dredged only" was blasted in 1900, at a cost of $2,600, or $2.60 per cubic yard, which, added to the cost of dredging, $1.74, in 1901, gives $4,340, or $4.34 per cubic yard for total removal of material.

Cost of repairs to old guide piers, including charge for use and deterioration of plant.

Material.	Cubic yards.	Total cost.	Cost per cubic yard.
Riprap stone in place	200	$220	$1.10

List of dams and of materials used in their construction and repair during the season of 1901.

Designation.	Height above low water, 1864.	Riprap rock.	
		New work.	Repairs.
Sheet 47:	*Feet.*	*Cu. yds.*	*Cu. yds.*
Wing Dam 6½, widened	3.5	1,535	
Closing Dam 8, repaired and widened	5	2,345	80
Wing Dam 9, repaired	3.5		60
Trailing Dam 9½, repaired and widened	3.5	1,500	60
Total		5,380	200
Grand total			5,580

Cost of dams, including charge for use and deterioration of plant.

Material.	Cubic yards.	Total cost.	Cost.		
			Towing, per cubic yard.	In place, per cubic yard.	Total per cubic yard.
Riprap rock in place	5,580	$6,138.74	$0.19	$0.91	$1.10

Financial statement for improvement of Rock Island Rapids for season of 1901.

Amount expended in field	$4,097.31
Add quota of general superintendence and office expenses	369.06
Add for use and deterioration of plant	3,632.37
Total	8,098.74

Distributed as follows:

1. Rock broken up in 1900, but dredged in 1901	1,740.00
2. Dams 6½, 8, 9, and 9½	6,138.74
3. Guide pier 20	220.00
Total	8,098.74

BUOYS ON ROCK ISLAND RAPIDS.

The bouys were thoroughly repaired and painted, and the number needed were reset between May 6 and 16. New anchor bolts and chains were put in for a few of them. A new buoy, 12½, was established at the outer end of dam No. 3 at head of Campbells Chain. As heretofore, those carried away by boats were soon afterwards replaced. Between November 4 and 6 the ranges were finally gone over and adjusted and the buoys taken up and stored with the fleet for the winter

Total number of buoys in the system, 36.

Cost of buoys for the season, $320.

MISCELLANEOUS.

For the benefit of navigators long buoys were placed in the fore part of the season on the outer ends of dams in the localities given below, viz, 3 at dams below Bellevue, 3 at those abreast of Clinton, and 4 opposite Comanche; total number, 10.

On August 1 the steamer *Urania*, in a very disabled condition, was towed by the towboat *Ruth* from mouth of Rock River to Rock Island levee.

J. B. Gordon, overseer, and J. B. Corken, recorder, performed their duties in a very creditable and satisfactory manner.

Very respectfully submitted.

J. C. McElherne, *Assistant Engineer.*

Maj. C. McD. Townsend,
Corps of Engineers.

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

United States Engineer Office,
Rock Island, Ill., January 2, 1902.

Major: I have the honor to submit the following report of operations for improvement of the Mississippi River in the division in my local charge for the calendar year ending December 31, 1901.

ROCK ISLAND TO NEW BOSTON.

Under project approved April 7, 1899, and allotment of $40,000 from appropriation of March 3, 1899, contractors Fetter & Crosby commenced operations June 4, 1901, and completed their contract December 2. This contract was approved August 26, 1899, the original time for completion being September 30, 1900; was extended to September 30, 1901, and afterwards the time limit was waived. The cost of inspec-

tion from October 1, 1900, to December 2, 1901, on which latter date the contract was completed, was charged to the contractors. The prices paid were 89 cents per cubic yard for rock and 26 cents per cubic yard for brush—very low figures. The first work done under this contract was the construction of a closing dam near head of Turkey Island Chute (mile 406). This dam, which is 980 feet in length and has its crest at an elevation of 4 feet above low water, was completed July 8, 1901, and operations were then transferred to the vicinity of Horse Island (mile 367–370). A survey of this locality had been made early in June and a project prepared for a 1,200-foot channel so located as to avoid, as much as possible, dangerous rocks and to define the limits between which rock excavation is necessary. This project contemplates the construction of 12 wing dams from the Illinois shore, 4 from Smiths Island, 3 from the Iowa shore below Horse Island, and 3 from Horse Island, as also the completion of the closing dam at Horse Island Chute. There were built 9 wings from the Illinois shore, 3 below Horse Island, 3 from Horse Island, and the Horse Island closing dam. These dams all have a crest elevation of 4 feet at low water. Late in the season considerable improvement in the channel was noted, both at Turkey Island and at Horse Island. It is desirable that the remainder of the Horse Island project be carried out at an early day.

This work was in local charge of Inspector A. J. Stibolt, whose duties were well performed.

List of works constructed and of materials used during the season of 1901, under contract with Fetter & Crosby, between Rock Island and New Boston.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 48:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Closing Dam 13	750	4	1,297.9	1,423.7
Wing Dam 14	550	4	1,233.1	2,300.8
Wing Dam 15	750	4	1,518.8	2,283.4
Wing Dam 16	900	4	1,699.4	2,804.9
Wing Dam 17	200	4	392.1	568.6
Wing Dam 18	1,100	4	1,928.8	3,053.5
Wing Dam 19	1,630	4	2,723.1	4,475.3
Wing Dam 20	750	4	1,616.5	2,242.7
Wing Dam 21	475	4	953.3	1,497.7
Wing Dam 22	300	4	573.9	896.9
Wing Dam 23	350	4	568.2	1,053.1
Wing Dam 24	200	4	463.8	646.6
Wing Dam 25	400	4	826.4	1,423.8
Wing Dam 26	225	4	360.6	680.1
Wing Dam 27	750	4	1,986.5	3,224.6
Wing Dam 28	250	4	268	450
Sheet 53:				
Closing Dam 8	980	4	3,125.4	4,694.9
Total	10,560	....	21,535.8	33,720.6

Financial statement for work between Rock Island and New Boston, under 1899 contract with Fetter & Crosby (entire contract).

Amount paid contractor		$27,934.24
Cost of local inspection, etc		210.88
Add quota of general superintendence and office expenses		2,665.85
Add for use and deterioration of plant		32.00
Total		30,842.97
Material put in works:		
Rock	cubic yards..	21,535.8
Brush	do....	33,720.6
Total	do....	55,256.4
Average cost per cubic yard in place		$0.558

I would say that the original estimate for the work above described, made from the survey of June, 1901, amounted to: Rock, 24,220 cubic yards; brush, 35,826 cubic yards; total, 60,116 cubic yards. This estimate proved to be greater than the actual amount by 4,860 cubic yards, of which rock 2,685 cubic yards, brush 2,175 cubic yards. This shrinkage was due in great part to the accumulation of sand at the dam site during progress of work.

To complete the project for this locality there are needed 5 wing dams from the Illinois shore, 4 from Smiths Island, and 1 from the Iowa shore at Linwood. The estimated amounts for such completion are: Rock, 10,146 cubic yards; brush, 20,294 cubic yards. The approximate cost is $18,000. A large amount of rock excavation, for which no estimate has yet been made, will also be needed to afford a clear channel. I submit a map showing the project for this locality.

FLINT CREEK TO IOWA RIVER LEVEE.

[Miles 411-440 on the Mississippi River.]

There was no field work carried on during the year. An inspection made in November showed the levee and its adjuncts to be in good condition, with trifling exceptions. The total amount appropriated for this levee, which is 35¼ miles in length, is $300,000, and the approved estimate is $305,000, exclusive of cost of drainage, repair and maintenance, right of way, shore protection, and levee bank revetment, on which necessary items there has been expended to date the sum of $27,642.99. The balance available December 31, 1901, was $3,043.27. No further work remains to be done except such portions of the proposed enlargement of section (shown on p. 2724, Report of Chief of Engineers, 1900) as funds may permit.

If the $5,000 of the original estimate not yet appropriated be granted, the entire needed increment can be put in place, but if no further funds are allotted it is possible to strengthen only those portions of the levee considered most unsafe.

I have presented a final report on this levee, with map, tables, and sketches, which I hope may be printed in the Report of the Chief of Engineers for 1902.

ROCK ISLAND HARBOR.

The sundry civil act of March 3, 1899, provides "That * * * five thousand dollars shall be expended for maintaining the harbor at Rock Island, Illinois" (mile 363). A project for rock excavation was submitted March 30, 1899, approved April 7, and carried out during the season of 1899. Fifteen thousand dollars additional will be needed to complete the work under the approved project.

DAVENPORT HARBOR.

The sundry civil act of March 3, 1899, provides "That * * * ten thousand dollars shall be expended to deepen the harbor at Davenport, Iowa, from the Government bridge to the island owned by the city of Davenport, in the Mississippi River" (mile 363). No project for the expenditure of this appropriation has been presented, as the depth in the harbor is sufficient for purposes of navigation in the locality indicated.

BUOYS.

A system of buoys is kept in operation each season to mark the location of the ends of certain dams which are dangerous to raft navigation at stages when the crest of the dam is covered by water to a depth of less than 3½ feet. The regular buoys in my subdistrict are 13 in number.

SURVEYS.

There were made during the season examinations of the river in vicinity of Horse Island (miles 367-370, Buffalo (mile 373), Montpelier (miles 376-378), Turkey Island (miles 405-408), and Henderson River (mile 437), and maps of same have been plotted

IN GENERAL.

The *Mackenzie* found in August, in passing, the following-named depths, in feet, at various crossings. The stage of water above low water and the distance from St. Paul are also given. In each case mentioned the probable depth at extreme low water is less than 4 feet.

Stage of water, 1.5.—Foot of Horse Island (mile 369), 4.4; above Linwood (mile 370), 5; opposite Linwood (mile 371), 4.5; Dodges (mile 371), 5.4; below Buffalo, at Island 322 (mile 374), 4.9; above Montpelier (mile 376), 4.7; Vela Chute (mile 378), 4.5; Pine River (mile 380), 5.2; below Fairport (mile 381), 5.1; foot of Hershey Chute (mile 388), 5.4.

Stage of water, 1.—Above Port Louisa (mile 401), 4; Turkey Island (mile 407), 4.9.

Stage of water, 0.8.—Above Johnsons Island (mile 424), 4.1; foot of Otter Island (mile 439), 4.1.

The localities most in need of improvement appear to be at foot of Horse Island, opposite Linwood, below Montpelier, above Port Louisa, at Johnsons Island, and foot of Otter Island.

Very respectfully, your obedient servent,

C. W. DURHAM,
Assistant Engineer.

Maj. C. McD. TOWNSEND.
Corps of Engineers,

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 2, 1902.

MAJOR: I have the honor to present a report on Flint Creek-Iowa River Levee, beginning with the preliminary surveys in 1894 and continuing to its completion in 1900.

The river and harbor act of August 17, 1894, provides for a survey on the west side of the Mississippi River, commencing at the mouth of Flint Creek, in Des Moines County, Iowa, and running along the west bank of the river to the mouth of the Iowa River, with a view to improving the navigation by preventing the water from overflowing the natural and artificial banks along those parts of the river and deepening the channel. This survey was assigned to Maj. (now Col.) A. Mackenzie, Corps of Engineers, who placed me in local charge, in which I remained, under his direction and that of Lieut. Col. W. R. King and Maj. C. McD. Townsend, until the completion of the levee in 1900. Surveyor E. E. Barrett had charge of the field work, both of surveys and construction.

Preliminary survey.—The preliminary survey was made in September and October, 1894, with the understanding that Congress desired an estimate of the cost of preventing the overflow of the west bank of the river between the Iowa River and Flint Creek by the erection of artificial banks where needed. A transit line was run from a point above high water on the Iowa River down the south bank of that river to its mouth, thence down the west bank of the Mississippi River to the mouth of Flint Creek, and up that creek to high ground at the foot of the bluffs. The first 4 miles of this line ran on top of the old Iowa River levee, on which very little work was needed. A line of levels was run over the transit line and topography was taken adjacent, additional features of the bottom lands between the river and the bluffs being ascertained from the maps of the Mississippi River Commission. A map was submitted showing the located line in plan and profile, with sufficient topography, bench marks, grade elevations, high-water marks, etc., for a full understanding of the subject. The questions of outlets and interior drainage were not considered, and no provision was made in the estimate for purchase of right of way. The length of levee proposed was about 42 miles, including cross levees on both sides of De Soto Creek. Estimates were made for an earthen bank with a slope of 3 on 1 on the river side and 2 on 1 on the back side, with 4 feet width of crown. The grade of the top of the bank was placed at 3 feet above high water of 1888, the highest water since 1851 (high water 1851 was about 1.5 feet higher than that of 1888). The preliminary estimate was as follows:

1,855,193 cubic yards earthwork, at 15 cents	$278, 278. 95
Add about 10 per cent for engineering and contingencies	26, 721. 05
Total	305, 000. 00

Appropriations.—From various appropriations in the river and harbor and sundry civil acts for improving the Mississippi River from the mouth of Missouri River to Minneapolis, allotments for the Flint Creek-Iowa River levee were made by Congress as follows:

By act of—	
March 2, 1895	$85,000
June 3, 1896	75,000
June 4, 1897	50,000
July 1, 1898	40,000
March 3, 1899	50,000
Total	300,000

The total amount appropriated is $5,000 less than the preliminary estimate.

Location.—Early in May, 1895, a party was put in the field to make a permanent location of the levee, and this work was completed in July. It was decided to run the levee across De Soto Creek instead of building up both sides of the creek, and this change, together with other smaller changes in the line, reduced the length of the levee 7 miles and the estimates 110,000 cubic yards. After the final location had been determined, the entire line was cross sectioned, slope and mile-station stakes were set and computations of quantities made, and, later, borrow pits and right of way were staked out, putting matters in proper shape for construction work.

The total cost of these surveys, including the establishing of bench marks and recross sectioning of several miles, and in fact all engineering and surveying expenses, except the inspection of contract work, was $5,794.72.

Right of way.—After examining the statutes of Iowa and investigating the methods in common use for procuring right of way for levees in the South and elsewhere, and no similar case to that presented by this levee being found, it was decided to apply for advice to the Judge-Advocate-General, through the Chief of Engineers. The Judge-Advocate-General stated as his belief that the levee should not be built until the United States had acquired an easement in the land for the purpose of constructing and maintaining the levee and of taking the necessary material for its construction, and he presented a brief form of deed for that purpose. He also stated that the deeds should be acknowledged and recorded, and added that if the easement to construct and maintain the levee could not be secured by gift or reasonable payment the Secretary of War had authority under the act of April 24, 1888, to acquire such easement by purchase or condemnation. The following is the form of deed that was used, which is the same as above mentioned:

"In consideration of one dollar, the receipt of which is hereby acknowledged, I (or we) hereby grant and convey unto the United States of America forever the right to construct and maintain a levee on and to procure material for such construction from that portion of my (or our) land situated in Louisa County, State of Iowa, and described as follows: Being a strip of land one hundred and twenty-two (122) feet wide on the outside and forty-two (42) feet wide on the inside of the center line of the levee as now located on my land in the SW. ¼ of NW. ¼, sec. 5, T. 73 N., range 1 W.

"Signed and sealed this 15th day of February, 1896

"LILLIAN E. DAVIS,
"GEORGE R. DAVIS.

"STATE OF ILLINOIS,
"*County of Cook, ss:*

"On this 15th day of February, 1896, before me, E. O. Weldin, a notary public for Cook County, personally came Lillian E. Davis and George R. Davis, her husband, to me personally known to be the identical person (or persons) whose name is (or whose names are) affixed to the above deed as grantor (or grantors), and acknowledged the execution of the same to be his (or their) voluntary act and deed.

"Witness my hand and official seal the day and year above written.

"[SEAL.]
E. O. WELDIN,
"*Notary Public.*"

The right of way for the 35¼ miles of levee in Louisa and Des Moines counties was given to the United States free of charge, chiefly by the owners, except 2,720 linear feet in sections 24 and 33, which, on account of the emergency of contractors waiting to go on the land to build the levee, it was found necessary to purchase at a cost of $400. The supervisors of Des Moines County bought and paid for about 4 miles of the right of way near the Flint Creek end of the levee. The total cost to the United States for right of way, including the recording of the deeds, was $444.75.

Maintenance.—There being no provision for maintenance of the levee and no State law under which the land owners benefited could be compelled to provide right of way and keep the levee and its appurtenances in repair, the necessary legislation (similar to that in force in the State of Illinois) was compiled in this office and introduced in the general assembly of Iowa in 1898. A bill was passed embodying our suggestions and became law, as chapter 46 of the acts of the twenty-sixth general assembly of the State of Iowa. This law gives the supervisors in each and every county where the United States may have undertaken the building of a levee * * * "the right and power to aid in the doing of such work, procuring right of way for the same, maintaining and assisting in maintaining the same, and providing a system of internal drainage made necessary or advisable by the construction of such levee whenever in their judgment such work will be conducive to the public health, convenience, or welfare."

The methods of procedure to organize boards of levee commissioners to make the necessary surveys, to classify the lands, and to collect the appropriate tax from landowners in accordance with the betterment, are fully set forth in the act. Nothing has been done as yet by the supervisors of Louisa and Des Moines counties in the matter of the appointment of levee commissioners and engineers, although they have frequently been requested by this office to take action. There appears to be no disposition on the part of either county to maintain the levee, the impression no doubt being prevalent that the United States should or would take care of its own work. It remains to be seen whether the Government will appropriate funds to maintain the levee.

There has been expended by the United States for repairs and maintenance to June 30, 1902, including the sowing of grass seed at various times, the sum of $1,476.40.

Construction of levee embankment.—The initial appropriation contained in the sundry civil act of March 2, 1895, provided:

"That * * * eighty-five thousand dollars thereof shall be expended to commence the work, under the direction of the Secretary of War, from the mouth of Flint Creek, in Des Moines County, State of Iowa, and running along the west bank of the river to the mouth of the Iowa River, with a view to improving the navigation by preventing the water from overflowing the natural and artificial banks along that part of the river, and deepening the channel in accordance with the survey reported on January 3, 1895, and the accompanying estimate."

It was necessary in order to prevent overflow from the Iowa River to commence the levee at a distance of about 5 miles up the Iowa River, connecting with the old county levee, which runs farther up (about 4 miles) to high ground. At the lower end it was necessary, for a similar reason, to carry the line up the left bank of Flint Creek about 1 mile. The dimensions of the levee bank at first proposed and as built in 1895–1897 were 4 feet width of crown, with slope of 3 on 1 on the river side and 2 on 1 on the back side, with grade 3 feet above high water of 1888, as in the preliminary estimate.

Specifications of many southern levees were studied, as also those of the Sny and Warsaw-Quincy levees, and a set of specifications adapted to the Flint Creek-Iowa River levee was prepared, the important sections of which are given below:

"*Character of work.*—Work under these specifications will include all excavations and embankments required for the construction of the levee; cutting all ditches or drains about or contiguous to it; the excavations or embankments necessary for reconstructing roads or passways in cases where they are destroyed or interfered with by its construction, and all other excavations and embankments connected with or incident to its construction or for its preservation or protection; the grubbing and clearing of all timber and vegetable matter on the base of the levee to the slope stakes, and the felling of all trees within twenty feet of the base of the levee.

"*Method of construction of new levees.*—The levee shall be constructed in the following manner: The ground to be occupied by the levee must first be cleared of trees, stumps, logs, weeds, brick, trash, and all perishable or objectionable matter; all trees and stumps shall be grubbed out by the roots to three feet beyond the slope stakes. The entire surface must then be thoroughly broken with a spade or plow in order to form a bond with the earth deposited; and such topsoil as in the opinion of the engineer in charge is unfit for the foundation shall be removed and deposited to form a banquette on the land side of the levee, together with such topsoil from the borrow pits as he may direct, and only clean earth, free from vegetable matter, is to be placed in the embankment which forms the levee proper. A muck ditch shall then be cut, when required by the engineer in charge, of such dimensions as he may direct, all stumps or roots in or crossing it being carefully taken out and removed beyond the base of the levee. The muck ditch must be cut three feet from the center line of the levee on the side next to the river, great care being taken not to displace any of the stakes of the center line. After inspection and measurement the muck ditch must be filled in by scrapers with approved material obtained from without the base of the levee and thoroughly tamped while being filled by the teams passing over the material, to the satisfaction of the engineer in charge or his designated agent. All the foregoing work shall be completed for a proper distance in advance of the embankment. When this has been done, embankment construction shall be commenced, the slopes to be started full out to the side stakes and be carried regularly up to gross fill or height, in layers not exceeding two feet in thickness, when moved by scrapers and one foot when moved by wheelbarrows. In wheelbarrow work the earth will be carefully tamped either by wheeling over the embankment or by employing one rammer to two wheelbarrows. All embankment above the water line at a five-foot stage shall be covered with black soil or suitable soil to sustain vegetation to a thickness of four inches.

"*Muck ditch.*—The muck ditch will be paid for when the levee is completed over it at the same rate per cubic yard as the embankment. This ditch is to be, ordinarily, four by four feet.

"*Obtaining earth.*—Material for the levee will be procured on the river side, unless otherwise directed by the engineer in charge, from the right of way as staked out. In excavating and removing it care must be taken to injure or disfigure the land as little as possible. In no case must it be obtained within twenty feet from the base of the levee on the river side, and the slope of the pit next to the embankment must not be steeper than two base to one perpendicular. If from unavoidable causes it becomes necessary to procure material on the land side of the levee it must not be taken within sixty feet of the toe of the slope. But it is not to be taken from the land side at all unless upon the written order of the engineer, designating the place. Any encroachments upon the limits of either side will be measured by the engineer in charge, or his designated agent, and deducted from the amount of the final estimate. At such intervals as may be directed by the engineer in charge, or his designated agent, traverses must be left across the borrow pits to prevent the flow of a current along the levee. The distances between these traverses will not be more than five hundred feet. They shall be at least ten feet wide on top, with slopes of one on two. All levees shall be estimated in embankment and not in excavation, and be paid for by the cubic yard. Borrow pits must not exceed three feet in depth at the berme, but they may be gradually deepened until at a distance of one hundred feet they may have a depth of six feet. No claim will be entertained or paid for hauling material long distances, known as overhaul.

"*Shrinkage.*—The allowance for settling or shrinkage of embankment will be one-tenth, regardless of the material used; and no embankment that is not carried up one-tenth higher than the established grade will be paid for. The allowance for shrinkage or settling must be so disposed on tops and slopes as to give the required width of crown and to fill out the slopes so as to make plane surfaces from edge of crown to base of levee. Nothing will be paid for this settling or shrinkage. The contents of the levee, computed to the established grade only, will be paid for.

"*Drains, ditches, and channels.*—Drains, ditches, and channels for streams, when necessary for the proper prosecution of the work, must be cut by the contractor as directed by the engineer in charge, or his designated agent, and will not be paid for unless the material is placed in the levee embankment, when it will be paid for as part thereof.

"*Settlement of foundation.*—When a levee is constructed across a slough, or at any place where settlement of the soil on which the levee rests is anticipated, the contractor will erect, at his own expense, such structures for determining settlement as the engineer in charge may designate, and shall construct the levee in such a manner as he may prescribe, and for all material used in restoring the sunken portions the contractor shall be paid at the same price per cubic yard as for the original embankment, but he shall receive no compensation unless the instructions and directions of the engineer in charge are fully complied with. In cases of settlement the contractor may be paid for the extra work by borrow-pit measurement.

"*Price per cubic yard.*—It is to be understood that the stated price per cubic yard for levee work covers all work under these specifications, including the felling of trees, cutting drains, or any other work necessary to complete the levee in accordance therewith."

Construction work was commenced October 4, 1895, and continued with but little intermission, except during winter months, until July, 1900, when the levee was practically completed. The first contract, let in 1895, covered 18 miles of the levee, beginning at the Iowa River end, and the contract price was 8.18 cents per cubic yard, the contractor, M. H. King, being the lowest of 21 bidders, the highest bid being 28.5 cents.

As Mr. King did not show sufficient energy in the prosecution of his work, his contract was annulled April 7, 1896, and it being thought desirable to complete the work to end of mile-section 8 before high water came, agreements were made in March, 1896, with several persons to do this work, amounting to 72,176.5 cubic yards, which was finished by the end of April, 1896, the prices paid ranging from 8 to 12 cents per cubic yard.

On May 28, 1896, a contract was made with John A. O'Keefe & Co. for mile-sections 9 to 18, inclusive, being the unfinished portion of the King contract. The O'Keefe contract was completed October 15, 1897, the amount of work performed being 526,762.7 cubic yards and the price 10.39 cents per cubic yard. Under contract with Edward Callahan, dated April 7, 1896, sections 19–22, inclusive, were built in 1896. These sections contained 179,359 cubic yards and the price paid was 8.99 cents per cubic yard.

In 1897, in addition to the O'Keefe work above mentioned, embankment was built under agreement with Kennedy & McDonnell in sections 23, 24, and 25 at 8.89 cents per cubic yard, with Cameron, McManus & Joyce in section 33 at 11¾ cents, and with John A. O'Keefe & Co. in section 34 at 10.9 cents. The amount of earthwork built during 1897 was 262,932.8 cubic yards.

In 1898 the levee cross section was changed by increasing the width of crown from 4 feet to 6 feet and the back slope from 2 on 1 to 2½ on 1, and agreements were made for embankment with W. O. Johnson & Sons for section 26 at 13.45 cents per cubic yard and section 31 at 16.5 cents; with Alfred Brainard for section 27 at 14.5 cents and section 28 at 13.1 cents; with Cameron, McManus & Joyce for section 29 at 14.5 cents and section 30 at 16 cents, and with Batt Foley for section 32 at 12 cents. John A. O'Keefe & Co., abandoned their work on section 34, and the section was assigned to Cameron, McManus & Joyce, who completed it in 1898, the price paid being 12.75 cents per cubic yard. The amount of earthwork built in 1898 was 321,157.7 cubic yards.

In 1899 Alfred Brainard abandoned his work on sections 27 and 28, and contract was made with W. O. Johnson & Sons to complete it at 22.5 cents per cubic yard. Batt Foley, who had section 32, also failed and the remainder of the work in this section was assigned to A. Helm & Son at 17 cents. The amount of earthwork built in 1899 was 538,771.2 cubic yards, including some small repairs in sections 4, 7, and 8, made by hired labor. In 1900 A. Helm & Son abandoned their work on section 32, and it was completed by Victor Swafford at 19 cents per cubic yard, making the levee continuous. The amount of earthwork put in place during the calendar year 1900 was 18,705.9 cubic yards, and the total amount from commencement to completion of levee, 1,856,153.4 cubic yards, which is 100,242.4 cubic yards in excess of the estimate made on final location, an increase due to the enlargement of cross section of the 7 miles built 1898–1900, but only about 1,000 cubic yards more than the preliminary estimate.

It will be noted that the cost of earthwork varied from 8 cents to 22.5 cents per cubic yard, which difference in price was only in part due to the relative difficulties of the work, but chiefly to lack of men and increased cost of forage in the later years of construction. When this levee was begun there was but little similar work in progress in the country and the competition was great; later on the state of affairs was very different. There was, however, sufficient saving on the earthwork from the original estimate to pay for right of way, drainage, repair and maintenance while work was in progress, revetment of levee bank, shore protection, and several minor items. There is also a balance available for emergency work of about $3,000.

The estimate for increasing to full size that part of the levee built prior to 1898 is 138,151 cubic yards, which would cost approximately 20 cents per cubic yard, or $27,630; but while all of this increment would doubtless be advantageous, it is thought that much less work will make the levee reasonably strong and permanent. On page 2724, Report of Chief of Engineers for 1900, is given a description of work needed, and also of that imperatively demanded. In the former case the estimate is 35,984 cubic yards earthwork and the probable cost $7,196; in the latter, 31,861 cubic yards and cost $6,372. A further appropriation of $5,000, which is the balance of the original estimate, would be sufficient with the funds now on hand to put the levee in satisfactory condition.

Map.—A map accompanies this report, on a scale of 1 inch to the mile, showing the levee line as divided into mile sections, the country and rivers adjacent, the shore protections and revetment. On the same sheet is a table of stations, grades, low-water elevations, quantities, etc., giving information usually shown on profiles.

There are also several sketches of details. The land benefited by construction of the levee, as shown on the map, amounts to 44,722 acres.

Levee sections.—The enlarged cross section (fig. 2) with 6-foot crown, river slope 3 on 1, back slope $2\frac{1}{2}$ on 1, occurs in sections 26–32, inclusive, and section 35, and also in small portions of sections 4, 5, 7, and 8, where additional strength was imperatively needed. In the remainder of the levee the cross section originally proposed (fig. 1), with 4-foot crown, 3 on 1 river slope, and 2 on 1 back slope, is used. I am now led to believe that in levees of this class it would be well to grade to the apex of the slopes, adding about 1 foot to grade so as not to diminish the cross section. By so doing the travel of vehicles on the levee top, which makes ruts to convey water into the levee, will be diminished or prevented, and as most of the burrowing animals tunnel the levees near the surface, the higher grade will lessen somewhat the danger from this source. The muck ditch is necessary to properly unite or mortise the new bank to the old to prevent a seam between them and the more so if through timber, where decayed roots or stumps might make a tunnel.

Drainage pipes, valves, and retaining walls.—In the preliminary estimate for building the levee no consideration was given to the interior drainage, it being at that time supposed that the landowners would provide the necessary pipes and valves, or sluices, as well as the right of way. It was soon discovered that the Government was in error in that respect, and, the levee being continuous, with no natural outlet at the lower end, the problem of getting rid of the surface and seepage water immediately confronted us. It was found advantageous to run pipes with out-flow valves through the bank at the various sloughs and small creeks, so that when the river was low the water would run out, and when high the tightly closed valves would keep it out.

A survey of the ground inclosed by the levee was made and also a calculation in regard to the proper number and location of the 36-inch iron pipes that would be required. Larger pipes and timber sluices at the Warsaw to Quincy levee have proved unsatisfactory. The pipes were laid upon the natural surface of the ground in the slough bottoms across which the levee ran, when of sufficient depression to insure outflow at low stages of the river; but when the ground was not low enough, ditches were dug to the proper depth and the pipes laid in them. The pipe used was the standard bell and spigot pipe, 36 inches internal diameter, seven-eighths inch thick, in lengths to lay 12 feet. They were not calked at the joints.

Each 12-foot piece weighed about 4,200 pounds, and the cost per ton delivered on cars at Oquawka and Burlington ran from $16 to $24.80, the latter price being paid in 1899.

Additional information in regard to the outlets is given in the following table:

Locality, number of lines of drainage pipes, etc.

Section.	Locality.	When laid.	Number of lines.	Kind of valve.
14	Prairie Slough	1895	1	Iron.
16	Iowa Slough	1895–96	3	Do.
17	Gates Lake	1896	1	Do.
18	Cox Lake	1896	1	Do.
27	Running Slough	1897	4	2 iron, 2 wood.
30	Laswell Slough	1897	4	Wood.
31	Tama Slough (head)	1897	2	Do.
33	Campbells Lake	1897	1	Do.
35	Tama Slough (mouth)	1899	4	Do.
35	Suesans	1899	1	Do.
35	End of levee	1899	2	Do.

At the inspection in November, 1901, all pipe lines, masonry, and revetments connected with drainage outlets, as also the iron valves, were found to be in excellent condition. A few of the wooden valves in sections 33 and 35 were found to be leaky and badly fitting.

Near upper end of section 18 there is a 4-inch drain pipe with plug valve put in by owner of adjoining property. There are on hand seven 12-foot lengths of 36-inch pipe in good condition, to be used in the event of further levee enlargement proposed, but not yet carried out on account of lack of funds. Five of these pieces are on the bank at head of Huron Slough (section 16), one near Cox Lake (section 19), and one at Campbells Lake (section 33).

There were three kinds of outflow valves used. The first was an iron valve (fig. 3) about 5 feet long, which cost $86.43; the second was also an iron valve similar to but about one-half as long as the first, and with a flange on the lip and planed faces, making a tighter and better joint. This valve cost $70. It was found that the pressure from the inside required to open these valves and permit outflow was too great—in fact, they would stand about 12 inches head without opening, so that it became necessary to rig up a counterbalance for each valve, with wire rope and an old rail pivoted properly. With this arrangement the valves work perfectly. The third kind of valve, which works well and is much cheaper, is made chiefly of wood (fig. 4). These valves cost about $11 each. They are similar to those long in use on the Muscatine levee at Port Louisa, where they have given good satisfaction. Care and attention are necessary to keep them in good shape. Some of the valves of this levee near the lower end are already out of repair, being slightly broken or warped in such a manner as to fit badly and allow considerable leakage. Another kind of valve was designed (fig. 5), which, although not tried as yet, may prove the most satisfactory. An offer was received to make these valves and put them on the pipes at $16.50 each.

At each pipe or series of pipes retaining walls were built, to keep the earth from sliding down and blocking the pipes. Copies of photographs (figs. 6, 7, and 8) show these walls as built and in course of construction, and also the revetment on the back side of the levee at the intake. An apron or revetment was also laid to receive the outpour and prevent erosion. The retaining walls were built under specifications similar to the following, and have proved very satisfactory.

"*Character of work.*—The work to be done consists in the construction of retaining walls around large drainage pipe on the Flint Creek to Iowa River Levee, at the mouth of Tama Slough, one-fourth mile below Tama Slough, and at Flint Creek. The walls are to be about 3 feet thick, 7 feet high, and from 12 to 30 feet in length, including foundation and coping. Concrete may or may not be used in the foundation, as may be found necessary.

"*Material.*—The stone must be sound, durable lime or sand stone of approved quality, at least 8 inches thick, and laid as coursed rubblestone. The mortar used shall be made of best hydraulic cement, mixed with clean, sharp river sand, in the proportion of 2 parts sand to 1 part cement. The mortar shall be made and used in such manner, and within such time after mixing, as shall be directed. The cement used must be one of the following brands or an equally good American Portland, viz: Atlas Portland, Rosendale, Egyptian Portland, Buckeye Portland, or Keystone Portland. All material, including stone, cement, sand, etc., must be furnished by the contractor, and at all times subject to approval. Concrete, if used, will be made in the following proportion: One part cement, 2 parts sand, and 5 parts gravel or broken stone.

"*Method of construction.*—The foundation must first be prepared as directed and meet with the approval of the engineer in charge. The stone must be well laid and bound together by headers extending entirely through the wall at least every 6 feet in length of wall, both headers and stretchers to be not less than 12 inches wide and at least as wide as thick. Stones must be roughly shaped with the hammer so as to give good joints and beds. Care will be taken to show a neat finish at the ends of the drains. All joints must be carefully filled with freshly made mortar and every stone well bedded in the same. All stone must be moistened before being laid, and before any succeeding course is laid upon it. After once setting, no stone shall be moved or joint broken without being taken up and reset.

"*Payment.*—All masonry and walling will be estimated and paid for by the cubic yard, and the number of cubic yards to be paid for shall be the actual solidity thereof by strict mathematical calculation. Any vacant space or spaces not actually filled with such masonry shall be excluded, any rule or custom in the section of country where such masonry or walling shall be done, as to measurement or otherwise, to the contrary notwithstanding. Payment will be made when the work is completed in accordance with above specifications. The prices per cubic yard will include the cost of furnishing all materials, including cement, and will include the cost of all other expenses necessary to the construction and completion of the masonry."

The cost of the drainage pipes and accessories amounts to $10,618.23.

Shore protection.—It was found necessary to protect the river bank at certain localities on the Iowa River (sections 1-7), especially where the old county levee was too near the edge, and also in Huron Slough (sections 17-18), where the bank was undergoing rapid erosion. These shore protections were constructed in the manner customary on the Upper Mississippi River, but were only carried up the bank to a stage of 7 feet and not to the top, as is usually the case. It would be well to continue these shore protections to the top of the bank at an early opportunity. In 1897 8,000 linear feet of the Mississippi River bank at Crutchfield Prairie adjacent to the levee (sections 22–23) was protected as a part of the general river improvement and paid for from the general appropriation. This shore protection was carried to the top of the bank. The following table gives details:

Shore protections adjacent to Flint Creek–Iowa River levee.

	Length.	Date of construction.	Location.	Remarks.
	Feet.			
Section 3	430	1900	Stations 154–158	Iowa River, 5 feet.
Sections 3 and 4	600	1896	Stations 158–164	Iowa River, 7 feet.
Section 4	790	1900	Stations 171–180	Do.
Sections 5 and 6	2,360	1896–97	Stations 248–272	Do.
Section 6	776	1897	Stations 292–300	Do.
Section 7	540	1897	Stations 317–323	Do.
Sections 17 and 18	1,380	1899	Stations 900–914	Huron Slough, 7 feet.

The total length of shore protection built is 6,876 feet, and the total cost $7,741.71, an average of $1.13 per linear foot.

Revetment.—The levee was exposed to damage when the river was over its natural banks at localities where it was quite near the river bank with no trees intervening to break the force of wind and waves. To guard against this exposure, a revetment of riprap, in a layer about 9 inches thick, was compactly laid on the exposed side of the levee, footing in a shallow ditch at the toe of the slope and running up to an elevation of about 1 foot below high water of 1888. At the Iowa Slough crossing, where the conditions were different and did not require so high a revetment, it was carried up only about 6 feet above low water.

Revetment of levee bank.

	Length.	Date of construction.	Location.	Remarks.
	Feet.			
Section 8	3,475	1899	Stations 378–414	Opposite New Boston.
Section 10	2,800	1899	Stations 502–530	Below New Boston.
Section 15	1,745	1898	Stations 750–768	Below Black Hawk Chute.
Section 17	1,280	1897	Stations 833–840	Iowa Slough; both sides revetted.
Sections 22 and 23	5,470	1898	Stations 1151–1206.	Crutchfield Prairie.

Total length of revetment built, 14,770 feet; total cost, $5,457.64—an average of 37 cents per linear foot.

Grass seed.—To start a sod on the levee we tried, in 1896, equal parts of blue grass, timothy, and red clover, 1 peck to the acre, sowing in the spring just before the snow went off the ground and in September. Tolerably good results were had from the spring sowing, but the seed sown in the fall did not thrive. In 1897 the same mixture was used on 8 miles of embankment, and in 1898 on 5 miles with only moderate success. In 1899 we used a mixture of 12 parts blue grass, 5 parts timothy, and 1 part white clover, but the cold weather in February destroyed the grass and the spring sowing was nearly all killed by the weeds. In 1900, on the advice of prominent seedsmen, we used 9 parts fancy red top, 13 parts blue grass, 16 parts red fescue, 16 parts hard fescue, 4 parts white clover, and 9 parts awnless brome, but with indifferent success, although the seed was thickly sown over the entire levee. An inspection made in November, 1901, shows the grass good on 10 miles, fair on 11 miles, and very scant on 14 miles—a result not commensurate with the amount of money expended.

Section posts.—These are red cedar posts, 4 inches square and 6 feet long, set in the crown of the levee on the lines at which the mile sections come together, painted white and with figures in black indicating the number of the section. These posts cost 70 cents each.

Bench marks.—The principal bench marks are three-fourths inch iron pipe, 3¼ feet long, with circular cast-iron base 6 inches in diameter and wrought-iron circular cap 2¾ inches in diameter and three-fourths inch thick. They cost 85 cents each, and are set on the back slope of the levee near the crown opposite each section post. There are also 99 secondary bench marks scattered along the levee, principally nails in trees.

List of principal bench marks on levee bank.

No.	Location at section post.	Station.	Elevation above Cairo datum,	Remarks.
			Feet.	
4	3–4	158	569.273	
5	4–5	211	567.410	Lower side of Zeigler Slough.
6	5–6	264	566.757	Midway between schoolhouse and residence of George Mosier.
7	6–7	317	565.631	Cultivated field near timber.
8	7–8	370	564,256	At mouth of Iowa River.
9	8–9	422	563.474	Opposite New Boston.
10	9–10	475	563.406	600 feet above bend in levee to west.
11	10–11	528	562.154	300 feet above lower end of revetment.
12	11–12	581	561.708	1,000 feet below Moorhead Cut-off.
13	12–13	638	561.233	Just below small clearing.
14	13–14	691	560.507	2,000 feet below Iowa Central Ry.
15	14–15	744	559.909	Edge of timber above Bratton's house.
16	15–16	796	559.782	Near county line near Sam Hardin's.
17	16–17	849	559.581	At house of J. Gottschalg.
18	17–18	902	558.377	Opposite upper end of riprap Huron Slough.
19	18–19	955	558.600	Lower side of timber.
20	19–20	1008	558.289	On prairie 800 feet above timber.
21	20–21	1060	557.986	100 feet below angle in levee.
22	21–22	1113	557.477	500 feet above road crossing.
23	22–23	1166	557.206	Upper side of Crutchfield Prairie.
24	23–24	1219	556.193	1,500 feet below Crutchfield Prairie.
25	24–25	1272	556.056	At angle in levee.
26	25–26	1324	555.680	Opposite closing dam in Dasher Slough.
27	26–27	1377	555.267	At upper side Moir Pocket Slough.
28	27–28	1435	553.840	1,600 feet below Running Slough.
29	28–29	1488	554.576	Midway between Jos. and Marion Gibb's houses.
30	29–30	1541	554.845	600 feet below large pond near road crossing.
31	30–31	1594	554.802	500 feet above head of Tama Slough.
32	31–32	1646	584.933	400 feet below road crossing.
33	32–33	1699	553.162	Near Oak Grove.
34	33–34	1752	551.795	At head O'Connell Slough.
35	34–35	1805	554.250	Where back slope changes to 2¼ to 1.
36	(*a*)	1868	553.175	

a At end of levee,

General remarks.—There were no special difficulties met with in the construction of this levee. Much of the ground was heavily timbered, requiring considerable tree cutting and grubbing, but there was, on the other hand, a great deal of open prairie and scattered timber. The soil was generally well adapted to levee construction, although several sand fills were not favorable to the growth of grass. There was but little shrinkage other than normal, due to quicksand and other poor foundation, although some extra work had to be done in reenforcing the bank at Iowa Slough, Campbells Lake, and Moorhead Cut-off, aggregating about 6,000 cubic yards, the bulk of which was at the first-mentioned locality. Nearly all earth was borrowed from the river side. In a few cases, where the fills were heavy, some earth was taken from the back side, but never nearer than 60 feet from the toe of the slope.

COST OF THE WORK.

Statement of expenditures from commencement to June 30, 1902.

Surveys for final locations, etc	$5,794.72
Right of way	444.75
Drainage	10,618.23
Superintendence and inspection	29,555.05
Repair and maintenance	1,476.40
Revetment of levee bank (14,770 linear feet)	5,457.64
Shore protection (6,876 linear feet)	9,645.97
Earthwork (1,856,351.4 cubic yards)	233,963.97
Total	296,956.73
Balance available	3,043.27
Average cost per cubic yard, including superintendence and inspection	0.142

The total amount appropriated for this levee, which is 35¼ miles in length, is $300,000, and the current approved estimate is $305,000, exclusive of cost of drainage, repair and maintenance, right of way, and levee bank revetment, on which necessary items there has been expended to date the sum of $27,642.99. No further construction work remains to be done except such portions of the proposed levee enlargement (shown on p. 2724, Report of the Chief of Engineers, 1900) as available funds may permit. If the $5,000 of the original estimate, not yet appropriated, be granted, the entire needed increment can be put in place, but if no further funds are allotted it is possible to strengthen only those portions of the levee considered most unsafe.

Very respectfully, your obedient servant,

C. W. DURHAM, *Assistant Engineer.*

Maj. C. McD. TOWNSEND,
Corps of Engineers.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, January 15, 1902.

MAJOR: I have the honor to submit the following report of operations for improving the Mississippi River in the division in my local charge, extending from Burlington, Iowa, to Hannibal, Mo., for the calendar year 1901:

BURLINGTON TO MONTROSE.

During the season the channel in this section was in fair condition, notwithstanding the protracted low water of the fall, which reached in September a stage of 0.3 foot above low water of 1864.

Under an agreement with Jacob Richtman, which was practically an extension of his contract dated July 17, 1899, a small amount of construction work was performed opposite Fort Madison (mile 463), the prices paid being 91 cents a cubic yard for rock and 26 cents for brush. Operations commenced April 29, 1901, and ceased May 30. Wing Dams 9 and 10 (sheet 64) were raised to low water, and a small gap in Wing Dam 8 was repaired. The cost of local inspection was paid by the contractor.

List of works repaired and of materials used during season of 1901 between Burlington and Montrose, under agreement with Jacob Richtman.

Designation.	Height above low water, 1864.	Material.	
		Rock.	Brush.
Sheet 61:	*Feet.*	*Cu. yds.*	*Cu. yds.*
Wing Dam 8 strengthened	4 to −10	82.1	....
Wing Dam 9 strengthened	0	914.1	1,459.5
Wing Dam 10 strengthened	0	539.6	839.7
Total	....	1,535.8	2,299.2

Financial statement for work of building and repairing dams and shore protections between Burlington and Montrose in 1900 and 1901, under contract and agreement with Jacob Richtman (entire work).

Amount paid contractor		$21,866.78
Cost of local inspection		591.79
Add quota of general superintendence and office expenses		739.87
Add for use and deterioration of plant		160.15
Total		23,358.59
Material put in place:		
Rock	cubic yards..	16,634.5
Brush	do....	25,754.9
Total	do....	42,389.4
Average cost per cubic yard in place		$0.551

QUINCY TO SAVERTON.

In this section the channel remained good, as also between Keokuk and Quincy, although the river reached a low stage during the fall. Work was carried on from March 17, 1901, to May 30, under contract with Fetter & Crosby dated July 24, 1899 (the time limit having been extended to June 15, 1901), in vicinity of Quincy (miles 523–524), Fabius and Orton islands (miles 524–527), Marion City (mile 530), and Whitneys Bar (mile 535). The prices paid were 96 cents per cubic yard for rock and 26 cents for brush, in place. Under the extension of the contract the contractor was charged with the cost of local inspection. Mr. Byron Layton was the inspector on this work, and performed his duties conscientiously and well.

In vicinity of Quincy, Wing Dam 19 (sheet 68) was built from Island 428 and repairs to the shore protection below the city were completed. At Fabius Island, Closing Dam 5 was raised to 5 feet above low water and the shore protection at both ends was repaired. At Orton Island, Closing Dam 6 was raised 2 feet at each end for a distance of 75 feet and the shore protection was repaired and extended downstream 75 feet. On the Missouri shore below Marion City 1,600 linear feet of shore protection was raised from a 6-foot stage to the top of the bank (15 feet) and extended downstream 200 feet. At Whitneys, Wing Dam 3 (sheet 70) was raised from 3 to 5 foot elevation and Wing Dam 4 from 2 to 5.

Owing to the high stage of water prevailing during progress of the work, much of it was done under considerable difficulty, and the dams did not appear, when the water fell, as smooth and regular as would have been the case had the river been lower at time of construction.

List of works constructed and repaired and of materials used during the season of 1901 between Quincy and Saverton, under contract with Fetter & Crosby.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 68:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Wing Dam 19	1,450	6.4	4,584.4	8,888.3
Shore protection below Quincy repaired		10	543.7	....
Closing Dam 5 raised		5	1,057.7	1,024.1
Closing Dam 6 raised		5	580.4	815
Sheet 69:				
Shore protection at Marion City raised		15	607.5	....
Sheet 70:				
Shore protection at Marion City raised		15	1,007	....
Shore protection at Marion City extended	200	15	435.6	424.9
Wing Dam 3 raised		5	372.9	554.3
Wing Dam 4 raised		5	723.1	745.8
Total			9,912.3	12,452.4

Financial statement for work of building dams and shore protections between Quincy and Saverton during 1900 and 1901, under contract with Fetter & Crosby (entire contract).

Amount paid contractor	$33,835.64
Cost of local inspection, surveys, etc	1,149.92
Add quota of general superintendence and office expenses	1,764.40
Add for use and deterioration of plant	82.07
Total	36,832.03
Material put in place:	
Rock ....cubic yards	25,751.6
Brush ....do	35,054.3
Total ....do	60,805.9
Average cost per cubic yard in place	$0.606

WARSAW TO QUINCY LEVEE.

No construction or repair work was done on this levee (miles 489–519) during the year. An inspection recently made shows the levee to be in apparently good condition.

There is available for maintenance and repairs $3,672.99.

BAR AT QUINCY.

No work was done on this bar (mile 521) during the year. An examination made early in the season shows that the areas dredged in 1899 and 1900 are shoaling, especially at the lower end.

There is available for further work on this bar $8,494.49.

DREDGING QUINCY BAY.

No work was done in Quincy Bay (mile 521) during the season, and no money expended.

There remains available for this improvement $1,651.71.

Very respectfully, your obedient servant,

M. Meigs,
United States Civil Engineer.

Maj. C. McD. Townsend,
Corps of Engineers.

REPORT OF MR. A. L. RICHARDS, ASSISTANT ENGINEER.

United States Engineer Office,
Rock Island, Ill., January 9, 1902.

Major: I have the honor to submit the following report of Mississippi River improvement work in the division in my local charge, between Hannibal and mouth of Missouri River, during the calendar year ending December 31, 1901.

HANNIBAL TO MOUTH OF MISSOURI RIVER.

The improvement of this section of river was carried on under project approved July 17, 1900. The work was performed by hired labor and use of Government plant, launch *Lucia* being used for towing. Owing to the small allotment available for this work, only a small force was employed. Brush was purchased under emergency contract, and was furnished by James Betts, of Rockford, Ill. The prices paid were 16 cents per cubic yard at Gilgal Landing, Ill., and 18 cents per cubic yard at Boyd Island, delivered on United States barges. Rock was purchased under emergency contracts with George W. Camery, of Hannibal, and Pratt & Cash, of Louisiana, except a small quantity bought in open market, under written notice, from J. G. Golike, of Alton. The prices paid were 55, 53, and 62 cents per cubic yard, delivered on United States barges.

Operations commenced July 15 and closed October 12, 1901. Launch *Lucia* was laid up in the Des Moines Rapids Canal at Keokuk, and the fleet was laid up for the winter in the harbor at Portage Island. Work was carried on at the following localities during the season: Maple Island (mile 656 from St. Paul), Portage Island (mile 642), Cincinnati Landing (mile 554), Mundys Landing (557), and Hickory Chute (565).

Vicinity of Maple Island.—Three wing dams, 38, 39, and 40 (sheet 84), were repaired by the addition of a small amount of rock, which was laid from the top of the shore protection up to the top of bank to prevent erosion during high stages of water. Shore protection on Missouri shore opposite Maple Island was repaired by the addition of a small amount of rock.

Vicinity of Portage Island.—The Portage roadway dam (No. 48, sheet 84) was surfaced up and put in good condition with one barge load of spalls.

Vicinity of Cincinnati Landing.—The shore protection on Illinois shore below Cincinnati Landing (sheet 73) was completed by extending the rock up to top of bank.

Vicinity of Mundys Landing.—The shore protection at Mundys Landing (sheet 73), built in 1895, and at that time only carried up the bank to a 6-foot stage, was completed by being extended up to the top of bank.

Vicinity of Hickory Chute.—The shore protection on Illinois shore below Hickory Chute (sheet 74), built in 1891 and 1893, was at that time only carried up the bank to stages varying from 5 to 10 feet above low water. It was completed by being extended up to top of the bank.

Plant.—The six model barges, Nos. 60, 61, 62, 87, 88, and 89, were condemned and six new flats (110 by 24 by 5 feet) should be built to replace them. The towboat *J. G. Parke* should have a new hull and repairs to machinery. The launch *Iris* is also in need of a new hull and repairs to machinery. The entire fleet needs considerable calking and some repairs to decks. These repairs will put the fleet in effective working condition for several seasons.

In general.—The channel throughout the division has been in good condition during the entire season, which has been one of low water, and the beneficial effect where works to any extent have been constructed is noticeable.

Surveys were made during the season in vicinity of Blackbird Island (mile 558) and Stag Island (mile 603), the maps of which were submitted to the office.

The localities most in need of improvement work are as follows: Saverton (mile 547), Gilbert Island (mile 552), Mulherns Field (mile 584), head of Hickory Chute (mile 562), below Clarksville (mile 580), Mosiers Island (mile 590), Stag Island (mile 603), Hatchet Chute (mile 629), and head of Portage Island (mile 641).

The greater part of the work done during the season consisted in carrying the shore protections from their varying stages up to the top of the bank. I do not consider it economical or advantageous to build shore protections only partially carried up the bank and then leave them to be completed at some future time, for the reason that such work is usually passed over for several years, during which time the water may have cut the top of the bank back so far that a large additional amount of rock may be needed to cover the flat surface, thus making the work more expensive than it would have been had the bank been graded and the protection completed at the time the mat was put in. The water does not grade this upper bank properly, and as much grading is finally needed as would have been necessary in the beginning. These facts are shown by the unusual cost of material put in place during the season.

Further details as to character and extent of work done are shown on maps submitted and in the appended tables:

List of works constructed and repaired and of materials used during the season of 1901 between Hannibal and mouth of Missouri River.

Designation.	Height above low water 1864.	Material.	
		Rock.	Brush.
Sheet 78:	*Feet.*	*Cu. yds.*	*Cu. yds.*
Shore protection below Cincinnati Landing, raised	12-14	2,635	....
Shore protection below Mundys Landing, raised	10-12	3,026.7	1,559.8
Sheet 74:			
Shore protection, Illinois shore	14	4,289.4	293.7
Sheet 84:			
Wing Dam 38, repaired	....	25	....
Wing Dam 39, repaired	....	25	....
Wing Dam 40, repaired	....	35.3	....
Transverse Dam 48, repaired	....	75.1	....
Shore protection, Missouri shore opposite Maple Island, repaired	....	20	....
Total	....	10,131.5	1,853.5

Financial statement for work of constructing dams and shore protections between Hannibal and mouth of Missouri River performed by hired labor during the season of 1901.

Amount expended in field during calendar year 1901	$11,439.20
Add quota of general superintendence and office expenses	944.54
Plant charge	2,154.23
Total	14,537.97
Material put in works:	
Rock, cubic yards	10,131.5
Brush, do	1,853.5
Total	11,985.0
Average cost per cubic yard:	
On barges	$0.519
For towing	.101
For putting in place	.334
For general superintendence and office expenses	.079
For plant	.180
Total	1.213

During the season I was at all times ably assisted by Mr. E. F. McDonald, receiver of materials, whose work was very commendable.

Very respectfully, your obedient servant,

A. L. RICHARDS, *Assistant Engineer.*

Maj. C. McD. TOWNSEND,
Corps of Engineers.

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER, ON PLANT.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 23, 1902.

MAJOR: I have the honor to present the following report on the floating stock or plant belonging to the improvement of the Mississippi River between the mouth of the Missouri River and St. Paul, for the calendar year ending December 31, 1901:

In this report "good" is in fine condition, wanting slight repairs or none; "fair" requires extensive repairs or such as are advisable; "bad" should be condemned or rebuilt. Pieces condemned are omitted.

The plant in question is as follows: One large towboat (*Coal Bluff*), good; 3 medium-sized towboats (*Alert, Fury,* and *Vixen*), good; 1 small towboat (*Ruth*), good; 1 small towboat (*Mac*), fair; 2 steam launches (*Louise, Lucia*), good; 2 steam launches (*Ada, Elsie*), fair; 2 steam launches (*Emily, Iris*), bad; 1 small steam launch (*Florence*), good; 3 naphtha launches (*Myra, Dart, Edith*), bad; 2 dipper dredges (*Vulcan, Phœnix*), good; 6 dump boats, fair; 1 steam-drill boat, good; 2 steam-drill boats, fair; 1 suction dredge, good; 1 suction dredge, fair; 1 double ponton, good; 18 small pontons, good; 2 pile drivers, fair; 1 pile driver, bad; 4 large quarter boats, good; 6 large quarter boats, fair; 6 small quarter boats, good; 5 small quarter boats, fair; 1 small quarter boat, bad; 3 large office boats, good; 4 large office boats, fair; 5 small office boats, good; 5 small office boats, fair; 1 small office boat, bad; 1 derrick boat, good; 1 store boat, fair; 1 boathouse, bad; 1 building boat, good; 3 building boats, fair; 1 building boat, bad; 17 large barges, good; 52 large barges, fair; 1 large barge, bad; 4 small barges, fair; and a large number of grasshoppers, loading boats, powder boats, and skiffs, mostly in good condition.

To the snag boat service belong the side-wheel steamer *Colonel A. Mackenzie*, good; and the stern-wheel steamer *J. G. Parke*, bad.

The Des Moines Rapids Canal has a small plant, consisting of 1 steam launch (*Stella*), fair; 1 dredge (*Ajax*), fair; 2 dump scows, good; 2 small barges, good; 1 small barge, fair.

There has been expended on the plant belonging to general improvement to December 31, 1901, $875,683.81, and its estimated value January 1, 1901, was $121,348.69.

Very respectfully, your obedient servant,

C. W. DURHAM, *Assistant Engineer.*

Maj. C. McD. TOWNSEND.
Corps of Engineers.

Y 3.

OPERATING AND CARE OF DES MOINES RAPIDS CANAL AND DRY DOCK.

The Des Moines Rapids Canal was open to navigation during the fiscal year 233 days, during which time there passed through it 867 steamboats and 126 barges, carrying 31,495 passengers, 15,632 tons of merchandise, and 6,602 bushels of grain. There also passed through the canal 40,761,204 feet B. M. of lumber, 15,100,000 feet of logs, 20,524,800 shingles, and 10,775,770 laths. The traffic statement of the canal shows a decrease over the previous year, chiefly in logs, lumber, etc., due to the fact that owing to high stages of water all rafts and nearly all boats passed over the rapids, March to June, 1902.

The expenses of operating and care of the Des Moines Rapids Canal and Dry Dock have been during the past year $41,805.50, the same being provided for under an indefinite appropriation made by act of July 5, 1884. Nominal repairs were made to lock walls, sluices, culverts, machinery, and dredging plant. Iron bridges were built across the sluices at middle and lower locks. Dredging was carried on from July 1 to October 31, 1901, and from April 21 to June 30, 1902, and amounted to 151,786 cubic yards, which makes the aggregate taken from the canal since June 30, 1878, 1,611,391 cubic yards.

The dry dock was in constant use. Dockage fees were collected from private parties to the amount of $195.

Details of canal and dry dock operations may be found in report of United States Civil Engineer M. Meigs.

There are no outstanding liabilities.

Money statement.

July 1, 1901, balance on hand	$604.09
June 30, 1902, amount drawn from Treasury during fiscal year under indefinite appropriation	41,932.03
	42,536.12
June 30, 1902, amount expended during fiscal year	41,805.50
June 30, 1902, balance on hand	730.62
June 30, 1902, returned to United States Treasury	730.62

ABSTRACT OF APPROPRIATIONS AND ALLOTMENTS.

By act approved—	
April 30, 1878	$7,500.00
June 18, 1878 (allotment)	32,500.00
March 3, 1879	40,000.00
June 14, 1880	30,000.00
March 3, 1881, expended during fiscal year ending—	
June 30, 1882	41,771.17
June 30, 1883	77,926.79
June 30, 1884	43,283.42
July 5, 1884, expended during fiscal year ending—	
June 30, 1895	44,506.50
June 30, 1886	43,009.53
June 30, 1887	42,152.84
June 30, 1888	42,802.35
By act approved—	
July 5, 1884, expended during fiscal year ending—	
June 30, 1899	$38,885.37
June 30, 1890	43,995.80
June 30, 1891	44,998.20
June 30, 1892	43,968.92
June 30, 1893	57,057.21
June 30, 1894	55,356.48
June 30, 1895	41,052.80
June 30, 1896	37,555.21
June 30, 1897	33,440.54
June 30, 1898	38,504.95
June 30, 1899	35,118.85
June 30, 1900	39,120.73
June 30, 1901	48,595.91
June 30, 1902	41,805.50
Total expended	1,044,909.07

* * * * * * *

Expenditures for operating and care of Des Moines Rapids Canal for fiscal year ending June 30, 1902.

Month.	Office and administration.				Canal and locks.			
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Current repairs.	Total.
1901.								
July	$375.00		$0.20	$375.20	$1,545.00		$240.19	$1,785.19
August	375.00			375.00	1,522.50	$116.68	84.71	1,723.89
September	375.00		10.50	385.50	1,470.00	12.71	187.82	1,670.53
October	375.00		21.90	396.90	1,470.00	267.04	322.59	2,059.63
November	375.00	$88.80	.20	464.00	1,458.00		1,414.43	2,872.43
December	500.00		56.41	556.41	1,012.50	46.01	190.73	1,249.24
1902.								
January	850.00	.65	1.00	851.65	932.50	86.93	106.31	1,125.74
February	500.00	6.00	6.00	506.00	1,056.16		67.63	1,123.79
March	500.00	12.50	12.50	512.50	1,042.50	10.00	432.03	1,484.53
April	375.00	37.21	37.24	416.74	1,645.50	55.52	56.66	1,757.68
May	375.00	132.93		507.93	1,485.00	56.86	61.39	1,603.25
June	375.00		28.40	403.40	1,485.00	26.50	51.80	1,563.30
Total	5,350.00	226.88	174.35	5,751.23	16,124.66	678.25	3,216.29	20,019.20

Months.	Dredging canal.				Grand total.
	Labor.	Supplies.	Current repairs.	Total.	
1901.					
July	$1,099.00	$67.49	$127.03	$1,293,52	$3,458.91
August	1,564.66	408.90	123.97	2,097.53	4,196.42
September	1,645.58	1,264.29	6.67	2,916.54	4,972.57
October	1,292.00	629.89	61.17	1,983.06	4,439.59
November	124.85	145.20		270.05	3,606.48
December			209.85	209.85	2,015.50
1902.					
January			640.08	640.08	2,617.47
February			42.52	42.52	1,672.31
March			587.87	587.87	2,584.90
April	610.02	188.88	711.03	1,509.93	3,684.35
May	1,374.32	416.04	212.15	2,002.51	4,113.69
June	1,273.00	925.81	282.80	2,481.61	4,448.31
Total	8,983.43	4,046.50	3,005.14	16,035.07	41,805.50

COMMERCIAL STATISTICS.

Traffic statement of the Des Moines Rapids Canal for the fiscal year ending June 30, 1902.

Month.	Boats up.	Boats down.	Barges up and down.	Passengers.	Merchandise.	Grain.	Lumber	Logs.	Shingles.	Laths.	Lockage at one lock.
1901.					*Tons.*	*Bushels.*	*Feet.*	*Feet.*	*Number.*	*Number.*	
July	82	75	26	11,002	2,621	3,000	13,380,090	1,600,000	3,094,300	3,224,650	206
August	63	64	12	6,887	2,797	....	11,778,000	5,050,000	....	2,868,600	224
September	59	59	15	2,023	1,573	....	3,225,700	4,900,000	1,590,500	357,520	190
October	54	64	18	1,710	896	....	7,005,414	1,800,000	15,425,000	3,100,000	191
November	18	36	21	300	416	402	....	1,750,000	....	....	67
1902.											
March	2	4	....	....	....	....	....	....	....	....	6
April	42	41	11	492	1,322	....	....	....	415,000	1,225,000	112
May	70	44	13	3,860	3,069	2,700	....	....	....	....	112
June	69	21	10	5,221	2,938	500	....	....	....	....	96
Total	459	408	126	31,495	15,632	6,602	40,761,204	15,100,000	20,524,800	10,775,770	1,204

Canal closed November 20, 1901, river closed by ice December 18.
Canal opened April 1, river opened March 10.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, July 1, 1902.

MAJOR: I have the honor to make the following report on "Operating and care of the Des Moines Rapids Canal" during the fiscal year ending June 30, 1902:

The canal was closed for the winter on November 20, 1901, and opened as usual April 1, 1902, being open 233 days and closed 132 days. During 1902 the water was mostly high, and all rafts passed over the rapids outside of the canal. In 1901 the water was low, and pretty much all traffic passed through the locks. These things affect the traffic statement.

REPAIRS TO BUILDINGS, LOCKS, ETC.

At the guard lock repairs were made to the pier head at the upper end of the lock. A course of stone 90 feet by 2 feet had become disintegrated by frost and water at about the low-water line. In October, when the stage was suitable, this broken course of stone was dug out to a depth of 6 to 18 inches and patched with Portland cement concrete, 1 part of cement to 2 of sand. So far the patches seem to stand well. One or two burst pipes in the hydraulic leads were dug up and repaired, the hydraulic cylinders in all the towers were overhauled and their fastenings were tightened and strengthened.

At the middle lock a new iron bridge was erected to replace the old wooden one crossing the sluice, which had been twenty-seven years in service and had become dangerous. The lock crew repaired and reset the coping stones about the gate columns where they had settled or had broken up from frost action. The repairs were made with Portland cement, 1 of cement to 2 of sand. The lock crew also finished pointing up the joints in the masonry of the lock chamber. There still remain repairs to make to the lower culvert openings and to the lower courses of the lock chamber, as well as to the sluice walls and breast wall of the sluice. I estimate that $1,000 will be needed to make these repairs, and the canal will have to be drained for the purpose, as most of the masonry in decay is below the ordinary stage of water carried in the canal.

At the lower lock several hydraulic pipes burst during the season and were dug up and repaired. A new iron bridge, similar to the one at the middle lock, was erected in place of the old one across the sluice. A heavy storm in June tore off a part of the machine shop roof, which was repaired with new sheet-iron covering where it had been displaced. One thousand dollars will be required to repair masonry of sluice walls, etc.

At the Sandusky sluice two new balance gates were put in to replace broken ones. The machinery of all these gates was overhauled and new keys fitted in the stems and gates. This sluice has gradually become filled with stone raised by the dredge from the bottom of the canal and carried through in the sluicing operations. The deposit had reached a depth of 4 feet, and very considerably reduced the effectiveness of the sluice, especially when used to sluice out the contents of the dump boats filled by the dredge. After the close of navigation a force of eight men was employed a week in removing the worst of this deposit, and in May and June the dredge was employed five days at the same work. Three cuts were made through the bar formed at the outlet of the sluice, and the dredge worked in the sluiceway itself, casting the stone up on the sides of the sluice. This stone remains there, and at a suitable opportunity will be loaded on barges and be distributed on the canal embankment. A sudden fall in the river necessitated the removal of the dredge before a really complete piece of work was done. The *Lucia* brought the dredge down over the rapids successfully at a stage of 9.5 feet above low water, but finding only 4 feet in places.

DREDGING CANAL.

Work has progressed very satisfactorily the whole of the working season in getting rid of the accumulated deposits in the canal. The year of 1901 brought but little sediment into the canal, and so a considerable gain was made in the arrears of dredging.

The dredge *Phoenix*, using the towboats *Vixen* and *Lucia* as tenders at different times, worked seven months steadily in the canal, mostly in the upper level.

Heavy repairs were made to the dredge during the winter. Her dipper and crane were overhauled, new teeth fitted to the dipper, and a heavy lip of 1¼-inch steel added, which gives better service in the canal than a set of teeth which seems to tear up the shelly rock in the canal bottom and thereby tends to choke up the openings of the sluice at Sandusky. This sluice was used to get rid of by far the greater part of the dredged material, and has greatly reduced the cost of the canal dredging. It is now indispensable.

The dredge was docked all winter, was calked and painted, and received a new cross timber to the gallows frame, and had all machinery put in good order.

The four dump boats were repaired as well as possible, but they are seven years old and too far gone with rot from the inside to be much longer serviceable. The lack of ventilation in these boats, which seems unavoidable, and the nature of the mud that necessarily gets inside in greater or less quantities, seem to allow but a short life to dump boats of pine and oak wood. Three sets of dump boats have been worn out in the canal in twenty years, and it would seem as if they should be now built of something more durable. I would suggest that during the coming fiscal year two new dump boats be built of steel, and two more in the next fiscal year, by which time all the present dump boats will be worn out. I estimate the cost of each boat, using the present gate chains and ratchet gearings, at $3,500.

In addition to the dredging in the upper level, the approach to the lower lock was dredged. Since 1892, when it was last gone over, a considerable bar had formed, on which boats got aground last season during low water.

Statement of dredging.

	Cubic yards.
Above guard lock	4,723
Below guard lock	18,748
Vicinity of Ballingers Creek	27,935
Vicinity of Sandusky	41,221
Vicinity of Prices Creek	55,019
Below lower lock	4,140
Total	151,786

MACHINE SHOP AT LOWER LOCK.

During the winter months the shop was employed making repairs to the machinery of the steamboats *Vixen*, *Lucia*, and *Mackenzie*, and to dredge *Phoenix* and launch *Edith*, as well as to the lock machinery. A distributing valve at the lower lock was completely overhauled and pump rods turned off. Boiler lagging of the lower lock was renewed, new plugs were made for all the boilers of the canal, and boilers and gauges tested. A new capstan was built for the *Mackenzie*, and one for the *Vixen*, of iron, and two old ones on the *Vixen* were extended so as to give greater holding power. New gearings for the capstans of the *Mackenzie* were made and the shafting lined up and altered.

OPERATING DRY DOCK.

The dry dock has been operated the whole year with a small force. Repairs were made to the saddle timbers of the gates and some of the closing and opening chains repaired. One barge, No. 82, was completely rebuilt of timbers on hand, making a new barge, 76 by 18 by 4 feet. One sounding-machine boat, No. 205, was built and equipped ready for use, being 50 by 18 by 3 feet, with a well in the center. During the year there were repaired 6 steamboats, 1 dredge, 2 flatboats, 4 dump boats, 3 quarter boats, 3 office boats, 1 drill boat, 1 naphtha launch. Eight flatboats were broken up for the material in them. Four private boats made use of the dock; fees collected, $195.

REPAIRING CANAL EMBANKMENT.

Owing to the action of the frost at the water line, a large portion of the slope wall lining of the canal embankment had shattered and threatened to undermine the good wall above, causing serious and expensive damage. In November, 1901, the *Lucia* was used to collect loose stone from the canal embankment where it could be spared, and some from the long rock pile at Montrose. This stone was unloaded along the embankment where repairs were needed, and in December a few men packed these stone into the holes, making a good temporary repair. Stone used, 594.7 cubic yards.

A leak in section 1 above the lower lock was treated by removing the slope-wall stone, filling the cavity with earth and then replacing the slope wall. This leak has been treated before and sheet piling was driven in the embankment some years ago. It is not certain that the cavity was anything more than a settlement of the new material put in when the repairs were made in former years.

MISCELLANEOUS.

During the coming year some repairs should be made to the piers on the rapids above the canal. The roads at the locks need regraveling, preferably with stone-crusher screenings. The office at the lower lock should have the inside renovated, having been in use twelve years without any attention whatever, excepting some painting to the outside woodwork. The building has settled a good deal, owing to its foundation being on made ground and the saturation of the soil at high water. If possible something should be done to strengthen this foundation.

BOOM BELOW LOWER LOCK.

The boom connecting the foot of the canal with the Keokuk and Hamilton bridge, about 800 feet long, has been in service since 1890, and in these twelve years the fence on each side of the boom has become so rotten that it should be rebuilt. The impact of boats and rafts now tear holes in it, and it is so far gone that it will be cheaper to rebuild it complete than to keep on patching it up. It would be a good plan to remove the present fence and use it for packing and filling the cavity in the center of the boom that now accumulates mud and tends to sink it. There is enough timber to make a practically solid boom, and the buoyancy of the structure will be greatly increased. This filling will keep out the mud and add much to the value of the structure. I estimate that it will cost $2,500 to make the repairs and changes indicated. The dry dock can be utilized for docking the boom with the least trouble and expense.

I have been assisted during the year by Mr. John R. Carpenter, superintendent, and Mr. O. S. Willey, clerk, both of whom deserve commendation for efficient service.

Very respectfully, your obedient servant,

M. Meigs,
United States Civil Engineer.

Maj. C. McD. Townsend,
Corps of Engineers.

Y 4.

OPERATING AND CARE OF ILLINOIS AND MISSISSIPPI CANAL AROUND LOWER RAPIDS OF ROCK RIVER, AT MILAN, ILLINOIS.

During the past fiscal year the canal was in operation from July 1 to November 16, 1901, and from March 25 to June 30, 1902, a period of 237 days. There passed through it 377 boats and barges, of an aggregate tonnage of 16,394 tons, carrying 996 passengers and 1,478 tons of merchandise. The business of the year was smaller than that of the previous year, and is not likely to increase to any extent until the canal is completed, unless the coal mines are reopened.

Repairs to the canal and its appurtenances were nominal. A new interlocking device was placed on the railway bridge at Milan. A survey of Rock River was made in the fall of 1901 from Lock 35 to site of proposed Lock 29, and maps were made and estimates for the improvement of the pool. A survey of Mill Creek and South Slough was made in March, 1902. A small amount of dredging was done by U. S. dredge *Ajax* below Lock 37 and at the upper entrance of Lock 35.

The expenses of the fiscal year ending June 30, 1902, were $11,014.93, the same being provided for under act of July 5, 1884.

There are no outstanding liabilities.

Money statement.

July 1, 1901, balance on hand	$1,113.98
June 30, 1902, amount drawn from Treasury during fiscal year under indefinite appropriation	10,000.00
	11,113.98
June 30, 1902, amount expended during fiscal year	11,014.93
	99.05
June 30, 1902, returned to United States Treasury	99.05

ABSTRACT OF ALLOTMENTS.

By act approved July 5, 1884, expended during fiscal year ending—

June 30, 1895	$225.00	June 30, 1900	$5,379.84
June 30, 1896	5,309.17	June 30, 1901	4,806.18
June 30, 1897	4,752.46	June 30, 1902	11,014.93
June 30, 1898	4,502.39		
June 30, 1899	3,304.92	Total	39,324.89

Summary of expenditures for operating and care of western section, Illinois and Mississippi Canal, for fiscal year ending June 30, 1902.

Month.	Superintendence, office expenses, supplies, engineering, and contingencies.	Operating and care: Locks and bridges.	Repairs.	Dredging.	Total.
1901.					
July	....	$293.48	....	$135.50	$428.98
August	$1,049.52	330.55	$36.36	840.98	2,257.41
September	766.42	307.94	....	15.55	1,089.91
October	584.84	302.69	964.68	....	1,852.21
November	204.00	305.50	261.23	....	770.73
December	7.50	302.88	1,064.02	....	1,374.40
1902.					
January	....	245.00	....	....	245.00
February	228.50	245.00	....	....	473.50
March	230.86	276.39	24.38	....	531.63
April	113.42	306.13	383.11	....	802.66
May	179.20	303.25	209.95	....	692.40
June	53.63	307.38	135.09	....	496.10
Total	3,417.89	3,526.19	3,078.82	992,03	11,014.93

COMMERCIAL STATISTICS.

.*Traffic statement of western section of Illinois and Mississippi Canal for the fiscal year ending June 30, 1902.*

Month.	Steamers.		Barges.		Number of passengers.	Tons of freight.	Lockages at three locks.
	Number.	Tons.	Number.	Tons.			
1901.							
July	31	546	7	648	197	220	95
August	66	789	7	570	350	102	110
September	30	269	5	700	111	225	75
October	83	3,772	46	5,511	53	869	174
November	10	405	5	603	9	55	20
1902.							
March	3	359	1	43	8	2	6
April	19	1,126	7	641	38	1	33
May	22	34	2	15	106	4	37
June	29	313	4	50	124	0	107
Total	293	7,613	84	8,781	996	1,478	657

Statement showing amounts dredged from canal and approaches.

	During year.	Total to date.
Below Lock 37 ....cubic yards..	11,599	28,455
Above Lock 35 ....do....	627	1,813
Total	12,186	30,268

Y 5.

OPERATING AND CARE OF GALENA RIVER IMPROVEMENT, ILLINOIS.

During the past fiscal year the lock was open to navigation from July 1 to November 18, 1901, and from April 5 to June 30, 1902, a period of two hundred and twenty-eight days, being in the meantime flooded sixteen days. There passed through 986 boats and barges, carrying 4,174 passengers and 1,714 tons of merchandise. The traffic, although very small, was about double that of the previous year. Small repairs were made to lock and grounds. The lock is now in very bad condition, having been much damaged by floods and ice. The dam is also out of repair. Considerable dredging was done, both in the pool and Harris Slough, the amount of material removed from channel being 46,795 cubic yards. A survey of the entire improvement was made in May, 1902, which shows a considerable filling up in the pool area dredged in 1901, although that in Harris Slough remains in good condition.

The expenses of the fiscal year ending June 30, 1902, were $9,166.68, the same being provided for under act of July 5, 1884.

Money statement.

July 1, 1901, balance on hand	$472.05
June 30, 1902, amount drawn from Treasury under indefinite appropriation	8,700.00
	9,172.05
June 30, 1902, amount expended during fiscal year	9,166.68
June 30, 1902, returned to United States Treasury	5.37

ABSTRACT OF APPROPRIATIONS AND ALLOTMENTS.

By act approved—	
September 19, 1890, purchase of improvement	$100,000.00
July 5, 1884, expended during fiscal year ending—	
June 30, 1894	635.68
June 30, 1895	6,000.00
June 30, 1896	3,400.00
June 30, 1897	8,588.20
June 30, 1898	5,890.05
June 30, 1899	3,226.87
June 30, 1900	8,750.94
June 30, 1901	12,077.01
June 30, 1902	9,166.68
Total	157,735.43

Summary of expenditures for operating and care of Galena River improvement for fiscal year ending June 30, 1902.

Month.	Superintendence, office expenses, incidental repairs, and contingencies.	Operating.		Repairs to lock.	Dredging.	Total.
		Labor.	Supplies.			
1901.						
July	$61.00	$125.00	....	....	$824.60	$1,010.60
August	10.43	....	$3.45	$2.00	712.92	728.80
September	97.50	125.00	7.20	....	1,498.81	1,728.51
October	243.81	290.00	7.50	114.01	2,874.56	3,529.91
November	38.30	151.67	....	42.00	105.85	337.82
December	408.35	160.00	....	35.00	....	603.35
1902.						
January	4.99	120.00	73.52	....	....	198.51
February	....	120.00	....	....	....	120.00
March	....	145.33	....	10.00	....	155.33
April	....	164.50	....	....	....	164.50
May	4.87	192.25	....	....	....	197.07
June	2.80	160.00	....	111.26	118.22	392.28
Total	872.00	1,753.75	91.67	314.30	6,134.96	9,166.68

COMMERCIAL STATISTICS.

Traffic statement of the Galena River improvement for the fiscal year ending June 30, 1902.

Month.	Boats up and down.	Passengers.	Merchandise.	Lockages.
1901.			*Tons.*	
July	195	1,017	16	154
August	178	736	45	96
September	96	268	162	49
October	161	474	545	111
November	43	74	162	32
1901.				
April	43	139	352	34
May	133	669	356	56
June	137	797	76	109
Total	986	4,174	1,714	641

River closed November 18, 1901, and opened April 5, 1902.

Statement showing amounts dredged from pool and Harris Slough.

	In fiscal year 1902.	To date.
Pool, above lock	27,380	67,495
Harris Slough, below lock	19,415	52,275
Total	46,795	119,770

Y 6.

IMPROVEMENT OF HARBOR AT LA CROSSE, WISCONSIN.

In 1902 hydraulic dredge 203 was kept at work pumping sand from the harbor bar and depositing it behind the bulkhead. About 84,000 cubic yards of sand was moved by the dredge, resulting in a material deepening of the water at the bulkhead landing, and a good current along the bulkhead and levee, which will insure the maintenance of the depth desired. The lower 600 feet of the area between the bulkhead and the main shore is filled up to a height of about 11 feet above low water, and another fill along the remainder of the bulkhead is about 800 feet long, 150 feet wide, and 8 feet above low water.

Money statement.

July 1, 1901, balance unexpended	$8,196.06
June 30, 1902, amount expended during fiscal year	5,017.11
July 1, 1902, balance unexpended	3,178.95

ABSTRACT OF APPROPRIATIONS.

By act approved—	
June 3, 1896 (allotment)	$5,000.00
March 3, 1899	12,000.00
Total	17,000.00

APPENDIX Z.

RESERVOIRS AT HEADWATERS OF MISSISSIPPI RIVER; IMPROVEMENT OF MISSISSIPPI RIVER FROM ST. PAUL TO MINNEAPOLIS, MINNESOTA; OF RIVERS IN WISCONSIN AND MINNESOTA TRIBUTARY TO MISSISSIPPI RIVER; OF WARROAD RIVER, MINNESOTA, AND OF RED RIVER OF THE NORTH, MINNESOTA AND NORTH DAKOTA.

REPORT OF MAJ. R. L. HOXIE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Mississippi River between St. Paul and Minneapolis, Minn.
2. Reservoirs at headwaters of Mississippi River, and Mississippi River between Brainard and Grand Rapids, Minn.
3. Operating and care of reservoirs at headwaters of Mississippi River.
4. Chippewa River, including Yellow Banks, Wisconsin.
5. St. Croix River, Wisconsin and Minnesota.
6. Minnesota River, Minnesota.
7. Red River of the North, Minnesota and North Dakota.
8. Warroad Harbor and Warroad River, Minnesota.
9. Survey of Red Lake and Red Lake River, Minnesota.
10. Survey of Otter Tail Lake and Otter Tail River, Minnesota.
11. Survey of Big Stone Lake and Lake Traverse, Minnesota and South Dakota.

United States Engineer Office,
St. Paul, Minn., July 17, 1902.

General: I have the honor to submit herewith report * * * upon the works of river and harbor improvements in my charge for the fiscal year ending June 30, 1902.

* * * * * * *

Very respectfully, your obedient servant,

R. L. Hoxie,
Major, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

Z 1.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN ST. PAUL AND MINNEAPOLIS, MINNESOTA.

The approved project and the report of progress of the work up to June 30, 1901, will be found in the Report of the Chief of Engineers for 1902, Part I, page 373.

ESTIMATE.

A revised estimate of cost for locks and dams Nos. 1 and 2 was submitted November 22, 1901, and published in House Doc. No. 164, Fifty-seventh Congress, first session. This estimate is $299,543 in excess of the limit of cost prescribed in the river and harbor act of March 3, 1899.

The river and harbor act of Congress, approved June 13, 1902, contains the following item:

> Improving the Mississippi River between the Chicago, Saint Paul, Minneapolis and Omaha Railroad bridge at Saint Paul, and the Washington Avenue Bridge at Minneapolis: The Secretary of War is authorized and directed to continue the work of improving the Mississippi River between the Chicago, Saint Paul, Minneapolis and Omaha Railroad bridge at Saint Paul, and the Washington Avenue Bridge at Minneapolis, in accordance with the plans now approved and such modifications in detail as may be deemed desirable by the Secretary of War: *Provided*, That the expenditure shall not exceed the present limit of cost until further estimate shall have been submitted and the present limit of cost extended by law.

WORK OF PAST YEAR.

LOCK NO. 2.

Lock No. 2 was virtually completed during the first half of the fiscal year. The concrete work and timber floor in lock chamber were finished. Both lock gates were nearly completed. The upper bay needle dam has been erected, guide piers and booms built, and the fill back of the land wall completed.

During the balance of the season it is intended to set the filling and emptying valves, to erect the lower bay needle dam, to install the maneuvering machinery for lower lock gate, complete wood filling in quoins of lower lock gate, and to place stop waters on upper lock gate. This will complete the lock ready for removal of cofferdam.

DAM NO. 2.

The cofferdam for west 273 feet of dam has been completed. Within the inclosure, the excavation has been nearly completed, all round and sheet piles driven, a timber crib apron built for all but 103 feet; the concrete foundation for abutment, for the major parts of the center and east piers and the lower hinge wall for west sluice gate have been built. Thirty feet of the cut-off wall have been built across the upper end of abutment.

The friability of the sand rock in foundation, and the behavior of water-bearing seams in the rock, induced changes in the construction of the foundation work. The use of foundation bolts in the sand rock was abandoned and the excavation carried down to a point where all seams which have been developed are intercepted, and where sufficient weight and strength can be given to the foundation. A continuous timber crib apron was substituted for the pile and concrete wall supports of the apron, and a foundation of concrete in mass was given to the bear trap sluices. The cut-off wall, upon which depends very largely the safety of the whole work, has been carried down to the extreme depth that was found practicable and efficacious in the case of the lock (34 feet 9 inches below the crest of the dam) to intercept seams which might develop dangerously if scour below the dam should remove the overlying sand and gravel from the sand rock and expose the seam. The use of a wooden diaphragm has been discontinued and the cut-off wall in the sand rock will be a vertical dyke of silica cement grout, averaging 5 to 6 inches in thickness, and having the consistency of tough clay or hardpan while wet.

The quality of the sand rock and the trouble experienced from water-bearing seams are described in the appended report of Mr. A. O. Powell, assistant engineer, reference to which is made for this and for a more detailed account of the year's operations.

LOCK AND DAM NO. 1.

Work was confined to obtaining flowage privileges and to making borings at site of the lock and dam. The appended report of Mr. R. Davenport covers the details of land negotiations. All the land required has been acquired except about 13 acres, and condemnation proceedings have been inaugurated to obtain title to that land.

The following tables showing the condition of balances, liabilities, etc., are submitted as the basis of the estimate of $250,000 asked to be appropriated.

Statement of balances.

July 1, 1902:	
Cash on hand	$31,745.92
In Treasury	408,470.97
Total balances	440,216.89

ESTIMATE OF EXPENDITURES DURING FISCAL YEAR ENDING JUNE 30, 1903.

Complete Lock No. 2	$86,756.03
Complete Dam No. 2	158,668.73
Surveys and lands at Lock and Dam No. 1	19,914.46
Construct cofferdam for Lock No. 1	20,000.00
Excavation and material for Lock No. 1	144,877.67
Roads and buildings at Lock No. 1	10,000.00
Total for fiscal year 1903	440,216.89

ESTIMATE OF EXPENDITURES DURING FISCAL YEAR ENDING JUNE 30, 1904.

Work and material, Lock No. 1	$250,000.00

There has been no commerce over this section of river during the year except that of drifting loose logs to market. No other kind has been possible on account of the swift current and numerous rocks and bowlders.

Amount expended to June 30, 1901, excluding outstanding liabilites	$393,231.73
Amount expended during fiscal year ending June 30, 1902, excluding outstanding liabilities	109,429.05

Money statement.

July 1, 1901, balance unexpended	$299,645.94
Amount appropriated by sundry civil act approved June 28, 1902	250,000.00
	549,645.94
June 30, 1902, amount expended during fiscal year	109,429.05
July 1, 1902, balance unexpended	440,216.89
July 1, 1902, outstanding liabilities	16,421.60
July 1, 1902, balance available	423,795.29
July 1, 1902, amount covered by uncompleted contracts	17,157.00
Amount (estimated) required for completion of existing project	[a]223,579.33
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	250,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

ABSTRACT OF APPROPRIATIONS.

By act approved—	
August 18, 1894	$51,000.00
July 13, 1892 (allotted by act of August 18, 1894)	49,877.67
By act of June 3, 1896	100,000.00
By act approved—	
March 3, 1899	150,000.00
June 6, 1900	185,000.00
March 3, 1901	157,000.00
June 28, 1902	250,000.00
Total	942,877.67

LOCKS AND DAMS, MISSISSIPPI RIVER, BETWEEN ST. PAUL AND MINNEAPOLIS.

[Printed in House Doc. No. 164, Fifty-seventh Congress, first session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, December 20, 1901.

SIR: In the river and harbor act of August 18, 1894, Congress adopted a project for the improvement of the Mississippi River between the Chicago, St. Paul, Minneapolis and Omaha Railroad bridge at St. Paul and the Washington avenue bridge at Minneapolis, and in the river and harbor act of March 3, 1899, the work was authorized to be prosecuted under the continuous-contract system. The adopted project was formulated in 1894 and contemplated the construction of two locks and dams, at a total estimated cost of $1,166,457. Since the work of construction was commenced it has been found necessary and desirable to modify to some extent the original project, for the reason that unexpected and unusual difficulties, due to natural causes, have developed at the locality. These difficulties, together with the fact that it has been deemed expedient to adopt a more thorough and improved type of construction, and the further fact that the cost of labor and materials has greatly increased since the original estimate of 1894 was made, have rendered it impossible to complete the work within the said estimate.

---

[a] The amount here given is the original estimate of $1,166,457, less the amount already appropriated, Congress not yet having authorized any increase in the limit of cost.

During the present year a board of engineers has been constituted, by authority of the Secretary of War, to consider and revise the plans for the two locks and dams, and, in a report dated April 22, 1901, the board recommended certain modifications, and gave certain estimates of cost based upon the present conditions at the locality and the present price of labor and materials. The board estimated that it would cost $733,000 to complete Lock and Dam No. 2, instead of $598,235 as given in the original project. It is believed that Lock and Dam No. 1 may be built for a similar amount.

In the accompanying letter, dated November 22, 1901, from the officer in charge of the improvement, it is estimated that the two locks and dams will cost $1,466,000 to complete, instead of $1,166,457, the original estimate. This is an increase of $299,543 over the amount heretofore pledged by Congress, and if the revised project is to be carried out and the work completed, it will be necessary for Congress to extend the limit of cost fixed by the aforesaid acts.

I have the honor to recommend that these papers be transmitted to the Speaker of the House of Representatives for the information of the Committee on Rivers and Harbors.

Very respectfully, your obedient servant,

G. L. Gillespie,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. Elihu Root,
Secretary of War.

REPORT OF MAJ. R. L. HOXIE, CORPS OF ENGINEERS.

United States Engineer Office,
St. Paul, Minn., November 22, 1901.

General: Referring to the Annual Report of the Chief of Engineers for fiscal year ending June 30, 1901, pages 2298–2301, I have the honor to invite attention to the necessity for an increase in the limit of cost now permitted by law for the completion of "Improving the Mississippi River between the Chicago, St. Paul, Minneapolis and Omaha Railroad bridge at St. Paul and the Washington Avenue Bridge at Minneapolis." It is recommended that Congress be asked to increase the limit of cost from $1,166,457 to $1,466,000, being an increase of $299,543.

The following revised estimate is submitted:

For Lock No. 2	$513,000
For Dam No. 2	220,000
	733,000
For Lock and Dam No 1	733,000
	1,466,000
Original estimate	1,166,457
Excess	299,543

This excess is due to the rise in price of material and labor since the original estimate, to unexpected difficulties encountered in the prosecution of the work, and to improvement in the type of work proposed.

A careful consideration of expenditures to date, with estimates for future work, indicates that the construction of Lock and Dam No. 2 will be completed within the sum estimated in the report of the Board of Engineers, dated April 22, 1901, viz, $733,000.

The surveys, borings, and studies for Lock and Dam No. 1, completed during the past season, indicate that a lock and dam similar to No. 2 may be built at the site of No. 1 at a cost not to exceed that of the former.

Some differences in detail will be necessitated by differing conditions of the site, and it may be desirable to modify slightly the type of structure. So far as this may be an element of doubt as compared with an exact duplication of work of ascertained cost, it is more than offset by certain advantages peculiar to No. 1—greater accessibility, proximity of sand and gravel for concrete, available plant from the work completed, and experience.

Very respectfully, your obedient servant,

R. L. Hoxie,
Major, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

Office Division Engineer, Northwest Division,
Chicago, Ill., November 23, 1901.

Respectfully forwarded to the Chief of Engineers, United States Army, recommended for approval.

O. H. Ernst,
Lieut. Col., Corps of Engineers,
Division Engineer, Northwest Division.

REPORT OF MR. A. O. POWELL, ASSISTANT ENGINEER.

United States Engineer Office,
St. Paul, Minn., *July 10, 1902.*

Major: I have the honor to submit a report of operations upon the improvement of the Mississippi River between Minneapolis and St. Paul during the fiscal year ending June 30, 1902.

LOCK AND DAM NO. 2.

The construction of Lock No. 2 was practically concluded last fall. There remains to be done the setting of the filling and emptying valves, erection of lower bay needle dam, the placing of stopwaters on edges of the upper lock gate (Chittenden drum weir), the completion of the wood filling in flat quoins of lower lock gate, and the removal of the cofferdam.

The construction of Dam No. 2 has been commenced at the west end, including the two sluices each 50 feet wide to be closed by reversed Parker bear-trap gates. The cofferdam for this portion of the dam was completed in October, 1901; the excavation has been made and the foundation is well under way.

By December 31 it is expected to fully complete the lock, except possibly removing the cofferdam; complete the west end of dam and sluices, and close by a cofferdam the gap of 320 feet between the present two cofferdams, through which the river now flows. The final completion of the lock and dam will be consummated next season.

LOCK NO. 2.

The past year's work, in detail, on Lock No. 2 has been the placing of 3,317.06 cubic yards of concrete; the laying of 50,000 feet B. M. of 6-inch flooring in lock chamber; the erection of the Chittenden drum weir upper lock gate; the near completion of the mitered lower lock gate; the construction of upper bay needle dam, timber crib guide pier, and boom; filling behind land wall, and the installation of a permanent plant for pumping out the lock when repairs may be necessary.

CONCRETE.

Of the 3,317.06 cubic yards of concrete, 2,304.19 cubic yards had a sandstone aggregate, and 1,012.87 cubic yards a granite aggregate. The proportions of cement, sand, and crushed stone were: 1:3:6 for 2,431.82 cubic yards (1-1):3:6 for 367.25 cubic yards, (1-2):3:6 for 135.97 cubic yards, and 1:2:4 for 382.02 cubic yards. Saylor's Portland cement was used to July 15, 1901, and Dragon Portland cement subsequent to that date. Last year's practice of mixing concrete wet has been followed with very satisfactory results. Ordinarily the concrete was made to quake easily under the rammer, but in some locations where it was difficult to thoroughly ram, particularly when structural steel was embedded in the mass, the concrete was mixed very wet, almost fluid.

UPPER LOCK GATE.

The upper gate is of the type known as the Chittenden drum weir. It extends the full width of the lock chamber, 80 feet; its rise is 13 feet 1 inch. The built-up steel anchor frames are embedded in a heavy mass of concrete. The gate itself consists of 20 steel frames made of channels, plates, and angles. The lower leg is 13 feet 3 inches long and sheathed with 4-inch plank; the upper leg is 15 feet 6 inches long, sheathed with 4-inch plank overlaid with a wearing surface of 2-inch plank; the curved portion is sheathed with 6-inch plank to permit dressing to true curvature. The erection of the gate was commenced in September, 1901, by setting the anchor frames. It was completed in November following. The stopwaters to prevent excessive leakage around the edges of the gate have not been placed. The concrete lock walls opposite the gate are protected by 4-inch oak planking and dressed to parallel planes at right angles to the hinge line. A three-way operating valve was placed in each lock wall. The valves are of cast steel. They are much larger but similar in design to the valves at Lake Winnebigoshish reservoir dam described on page 2315, Annual Report of the Chief of Engineers, 1901.

LOWER LOCK GATE.

The lower gate is of the miter type and has flat quoins. It is built entirely of steel, except the quoin, heel, and toe posts, which are made of oak blocks fastened to 15-inch 55-pound channels. Each leaf is 46 feet long by 24 feet 2 inches high. The frame is made of seven horizontal plate girders 42 inches wide, separated by vertical plate girder diaphragms. The sheathing is riveted to the downstream side of the leaves. The cast-iron balanced wicket emptying valves, 12 in number, are placed in the leaves of the gate, but have not been adjusted to exact position.

The maneuvering device has not been wholly provided; the chains and sheaves are on hand, but the gears have not been purchased.

The erection of the gate was commenced June 26, 1901, and completed, so far as indicated above, in November, 1901.

NEEDLE DAM.

The needle dam for permanent coffer in upper bay was built in January, 1902. It consists of four strongly built steel frames, spaced 16 feet between centers and 16 feet from lock walls. The frames are connected to each other and to the lock walls by five removable 12-inch 35-pound I-beams. The needles are of Oregon fir 6 by 12 inches by 10 feet 8 inches.

GUIDE PIERS AND BOOMS.

The usual form of rock and gravel filled timber cribs were built during August, September, October, November, and December, 1901. The cribs adjoining the upper ends of the concrete lock walls are 44½ feet long. Opposite and upstream from the river wall is a detached crib 9 by 31 feet connected with the crib adjoining the river lock wall by a timber boom 4 feet wide, 30 inches deep, and 62 feet long.

FILLING BEHIND LAND WALL.

The filling described in last annual report was completed in October, 1901.

PERMANENT PUMPING PLANT.

The plant consists of a 10-inch vertical centrifugal pump and a steam boiler and engine. The pump and engine are connected by a five-eighths-inch wire rope transmission drive.

DAM NO. 2.

The dam will consist of a concrete abutment, a sluiceway 51 feet wide, a concrete pier 13 feet wide, a sluiceway 51 feet wide, a concrete pier 13 feet wide, and a timber rolled dam 526 feet 4½ inches long. The total distance from abutment to river wall of lock, measured on crest of dam, will be 661 feet 4½ inches.

A cofferdam has been built to inclose the abutment, sluices, piers, and 138 feet of the roll dam.

The excavation within the inclosure has been completed for all but 100 feet of the apron to the roll dam, and the foundation work is nearly all in.

The sluices are to be closed by reversed Parker bear-trap gates.

The design of the dam provided for pile supports under roll dam; the piers were to be founded on concrete bases carried to sand rock. The sluices and apron below sluices and piers were to rest on concrete walls, carried down to and bolted to the sand rock. As the driving of round piles and the excavation proceeded the character of the foundation material was found to be very different from the inferences drawn from the borings. The sand rock not only appeared at irregular elevations, but its quality was exceedingly poor. The adhesion between the grains of sand is so slight that in most places it could, with some effort, be shoveled. In addition to the extreme friability of the rock, water-bearing seams were numerous, and when an outlet was afforded for the percolating water the seams were rapidly enlarged by scour. This condition determined a change in the manner of constructing the foundation work without altering the shape of the finished structure. The plan eventually settled upon was to carry the excavation under the piers, sluices, and apron to a uniform depth of 13 feet 3 inches below ordinary low water; to build a timber-crib apron filled with stone and gravel, the crib to be 53 feet wide at the piers and sluices and 38 feet wide for the roll dam. In addition, a cut-off wall at upper face of dam was projected to a depth of 23 feet 3 inches below the surface of ordinary low water below the dam.

The excavation and additional borings disclosed that under the position of the center pier and for about 25 feet on each side the sand rock had been scoured out to a maximum depth of 9 or 10 feet below the excavation level. It was not deemed necessary, and might have been impracticable, to excavate to that depth. The pier and about one-half of each sluice are founded on gravel; the other half of the sluice and the abutment and east pier are located directly on the sand rock. To guard against unequal settlement of the parts resting on gravel and sand rock, round piles were driven in the gravel. The rows are 3 by 4 feet centers.

COFFERDAM.

A portion of the cofferdam was built in 1900. The balance was completed during August, September, and October, 1901. The coffer is of the same general character as that built for the lock, and described in the 1900 annual report.

EXCAVATION.

The cofferdam was pumped out October 26, 1901. Excavating was commenced October 28 and continued into June, 1902, except for January and February, when cold weather interfered, with economical results. On the bed of the river was a layer of varying thickness of gravel, bowlders, and limestone débris underlaid by sand rock. The sand rock is white in color and inferior to that at the site of the lock.

About 15,000 cubic yards of material have been excavated. The major portion was taken over the river by the cable hoist and dumped into the river and along the bank above the lock.

LEAK IN SAND-ROCK SEAM.

On April 22, 1902, while the excavation was in progress and approaching the side of the cofferdam where the pumps were located, a break occurred in one of the seams of the sand rock. Within thirty-five minutes after the first gush of water was observed, 40 feet of the cofferdam had been injured, the inclosure filled with water and a large quantity of gravel carried in from the river by the rush of water. The seam was in the sand rock about 4 feet below the toe of the sheet piling of the cofferdam. The cofferdam was repaired, the sand rock protected by depositing gravel over it, and the inclosure pumped out April 28. At once another weak spot developed. It was then decided to temporarily abandon the work in that part of the inclosure and move the pumps to another point, in order that more gravel could be spread over the seamy sand rock. This work was done and the cofferdam pumped out again May 8.

The effect of the break was to emphasize the absolute necessity for precaution to prevent the destruction of the dam from similar causes, and it resulted in the changes in the plans previously mentioned. The break caused an expense of about $1,000.

ROLL DAM.

The piling for 138 feet of the roll dam were driven during December, 1901, and January and February, 1902. Two hundred and seventy-two round piles and 276 linear feet sheet piles were driven. The piles have been partially capped.

In cross section, the roll dam has a vertical upstream face to within 7 feet of the crest, then slopes 1 on 1 to the crest; the crest is flat and 3 feet wide; the down stream slope is 1 on 2 for a distance of 14 feet, then changes to 1 on 4 for a distance of 38 feet; the apron is to be horizontal, 30 feet wide, and the top 5 feet 3 inches below ordinary low water. The width of dam at base is 92 feet.

CEMENT AND CONCRETE.

Dragon Portland cement is being used at present. At the close of the year there were 1,750 barrels of pure Dragon cement, and 500 barrels of Dragon (1–2) silica cement on hand. Advertisements are out for 1,500 barrels of American Portland cement, which it is expected will be sufficient to complete the dam.

The tube mill was run during parts of April and June, 1902, grinding 1,479¾ barrels of Dragon (1–2) silica cement. The silica cement is used for grouting in the cut-off wall, and is also used with equal parts of pure cement in making concrete for foundation work. The silica cement ground in April was used early in June. Its activity was abnormal; for some unexplained reason it set in five minutes. This action is more strange from the fact that all cements, pure or silica, on the work before or since the April grinding acted in a normal manner.

The first batch of concrete was laid June 2, and a total of 1,413.2 cubic yards for the month. The concrete foundations for the abutment, the major portion of the two piers, and for the lower hinge wall of west sluice gate are in.

SLUICE GATES.

The two sluices are to be closed by timber bear-trap gates of the reversed Parker type. Their dimensions are: Base width, 44 feet; rise, 12 feet 6 inches; length, 50 feet.

The faces of the concrete piers and abutment at ends of gates will be protected by 4-inch Oregon fir. There will be a space of 2 inches between the fir protection sheathing and the gates. This space will eventually be partly closed by some form of stopwater. The clear opening of the sluice will measure 50 feet 4 inches.

All the material for the gates has been ordered. Most of the timbers are on hand, dressed, and sized.

CUT-OFF WALL.

The cut-off wall will be built of concrete, 3 or 4 feet thick through the gravel, and of (1–2) silica Portland cement grout 5 to 6 inches thick in the sand rock. The grouted wall will be jetted and constructed in the same manner as the cut-off wall around the lock described in the 1900 annual report, except that the board diaphragm is omitted. The sand rock is so soft that the diaphragm can not easily be inserted without danger of abraiding the sides of the cut and depositing sand at bottom of trench. Thirty feet of the cut-off wall across upper end of abutment were built during June. The grouting consumed 44¼ barrels of (1–2) silica cement.

LOCK AND DAM NO. 1.

The borings at site of Lock and Dam No. 1, commenced in June, 1901, were completed in September following.

The purchase of flowage rights has been under the direct supervision of Mr. R. Davenport, assistant engineer. He submits a separate report.

EXPENDITURES.

The cash expenditures have been itemized in the following table:

Statement of expenditures from commencement of work to June 30, 1902.

LOCK AND DAM NO. 2.

Miscellaneous:		
Lands, surveys, borings, water supply, etc	$30,819.27	
Roads, ditches, and side track	5,041.43	
Lock tender's house	242.69	
Carpenter and blacksmith shop	1,588.68	
Cement warehouse	954.77	
Stone and sand bins	2,476.52	
Clearing Government land	856.70	
		$41,980.06
Plant:		
Cableway	17,899.93	
Air compressor	18,894.88	
Pumping outfit	4,436.60	
Crushing outfit	2,776.80	
Mixing outfit	1,360.46	
Tube mill	5,000.00	
Pile-driver barges	2,050.95	
Tracks and cars	4,484.29	
Tools	5,169.45	
		62,073.36

LOCK NO. 2.

Cofferdam	20,080.89	
Stopping leaks	7,303.43	
Pumping	19,397.63	
Excavation	17,417.02	
Cut-off walls	8,009.03	
Timber and iron foundation bolts	34,813.03	
Cement	36,832.67	
Silica cement (exclusive of cost of materials)	7,776.95	
Stone	18,148.37	
Breaking stone	4,603.41	
Crushing stone	9,978.70	
Sandstone	4,864.82	
Sand	7,556.47	
Mixing and placing concrete	23,703.05	
Concrete forms	15,595.63	
Removing concrete	422.34	
Grouting foundation, upper lock gate	2,997.85	
Permanent subdrainage	4,114.39	
Snubbing posts	200.00	
Filling back of land wall	6,198.93	
Upper lock gate	12,865.85	
Lower lock gate	18,660.68	
Filling valves	47.26	
Permanent coffers	1,149.48	
Guide piers	2,995.34	
Dredging	1.03	
		285,734.25

DAM NO. 2.

Cofferdam	10,788.65
Pumping	2,567.13
Excavation	11,902.05
Leak in sand-rock seam	871.70
Cut-off walls	414.04
Round piles	2,747.27
Sheet piles	1,037.18
Timber and iron	12,157.56

Cement	$5,014.00	
Silica cement (exclusive of cost of materials)	700.71	
Stone	5,145.08	
Breaking stone	673.81	
Crushing stone	263.03	
Sand	58.66	
Mixing and placing concrete	134.25	
Concrete forms	520.73	
Sluice gates	2,115.45	
Coal	[a]1,329.00	
Blacksmithing	[a]711.10	
Supplies	[a]141.65	
Oil	[a]276.64	
Running cableway	[a]1,761.58	
		$61,331.27
Superintendence and contingencies:		
St. Paul office	26,127.17	
Office Chief of Engineers	480.00	
Office Division Engineer	62.50	
Inspection	3,361.54	
Watching	6,393.48	
Care of dredge	31.61	
		36,456.30

LOCK AND DAM NO. 1.

Lands, borings, surveys, water supply, etc	15,085.54	
		15,085.54
		502,660.78

Very respectfully, your obedient servant,

A. O. Powell,
Assistant Engineer.

Maj. R. L. Hoxie,
Corps of Engineers.

REPORT OF MR. R. DAVENPORT, ASSISTANT ENGINEER.

St. Paul, Minn., *June 30, 1902.*

Major: The following report as to the acquisition by the United States of title and right of flowage on lands to be affected by the proposed construction of Lock and Dam No. 1, Mississippi River, between Minneapolis and St. Paul, is respectfully submitted.

Negotiations for the acquisition of the flowage right by purchase were continued and to this date, in addition to those previously reported, deeds have been obtained from the owners of 6 tracts of land conveying the privilege of flowing 9.18 acres, including two streets in Minneapolis, without consideration, covering about 3,500 linear feet of river frontage; and an offer has been received from the owner of lot 4, section 32, township 29, range 23, part of an island in the river containing about 1.5 acres, which is now awaiting the approval of the Secretary of War.

The price offered and paid for the flowage right has in all cases been at the rate of $100 per acre for the area estimated to be affected.

The land on which flowage right has not been acquired has now been reduced to 6 tracts, containing 13.14 acres, covering about 1 mile of river frontage and a part of an island in the river, on which tracts all negotiations for purchase have so far failed, two owners refusing to consider the price offered by the United States and the remainder not being able to give clear titles on account of incumbrances, etc., on the land. A list of these lands, with full detail of metes and bounds, maps of survey, etc., has been prepared and delivered to the United States attorney, district of Minnesota, for the inauguration of condemnation proceedings.

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[a] At the close of season these items will be distributed. It is not convenient to do so in the middle of a season.

SUMMARY TO DATE.

Flowage right, acquired by purchase, 102.2 acres; acquired without consideration (city streets), 0.26 acre; acquired by United States reservation, 2.50 acres; to be acquired, approval pending, 1.5 acres.

Title to land acquired by purchase, 15.33 acres; acquired without consideration, 18.07 acres. To be condemned, 13.14 acres.

Total cost, $13,130.25, an average of $93.95 per acre for land and flowage right so far acquired. Six and twenty-one hundredths acres of land have been leased for use during construction.

A map of the river in the locality, showing details of flowage, etc., is herewith submitted.

Very respectfully, your obedient servant,

R. DAVENPORT,
Assistant Engineer.

Maj. R. L. HOXIE, *Corps of Engineers.*

Z 2.

CONSTRUCTION OF RESERVOIRS AT HEADWATERS OF MISSISSIPPI RIVER.

The approved project and the report of progress of the work up to June 30, 1901, will be found in the Report of the Chief of Engineers for 1902, page 374.

The expenditures during the fiscal year 1902 were $10,137.34.

At the close of the fiscal year the work of organizing the force for completion of the reconstruction of Leech Lake dam was well under way.

It is expected that Leech Lake dam will be completed early this fall, and the plant will then be transferred to Pokegama Falls dam. The necessary buildings will be erected and the materials for the reconstruction of this dam assembled during next winter.

Resumption of work on the dikes at Pine River reservoir is suspended under the terms of the act of June 13, 1902, pending further examination and survey.

The organization of parties for completing the resurvey of reservoirs was commenced, and it is expected to recommence field work early in July, 1902.

As soon as the resurveys are completed the necessary steps will be taken for the acquisition of flowage rights required.

Authority having been received from the Secretary of War, payment was made February 12, 1902, of the amount ($5,193.60) awarded by the commissioners in the Pokegama Falls condemnation proceedings.

Attention is invited to the accompanying report of Mr. R. Davenport on the subject of resurvey of the reservoirs and the acquisition of flowage rights.

The river and harbor act approved June 13, 1902, appropriates $250,000 for "Reservoirs at headwaters of Mississippi River and Mississippi River between Brainerd and Grand Rapids, Minn." Of this amount it is provided that $10,000 *may* be expended on the Mississippi River between Brainerd and Grand Rapids, Minn. Seventy-five thousand dollars is allotted for the purchase of necessary lands and flowage easements which may be developed by the resurvey of the existing reservoirs. It is estimated that $20,000 will be required to continue the resurvey of the reservoirs during the present season and $20,000 to complete the reconstruction of Leech Lake dam. The remainder is to be expended in the reconstruction of Pokegama Falls dam and in making the investigations called for in the act. Further appropriation will be required for the completion of work under the original project, and the estimate of cost of resurvey of the reservoirs will be somewhat exceeded (about $10,000), owing to the requirements of the act of June 13, 1902.

Total expenditures from appropriation for construction of reservoirs since July 1, 1898, when the cadastral surveys and the renewal of the old dams was began.

Contingencies:		
Main office	$9,564.59	
Inspection	1,666.20	
Road between Lake Winnibigoshish and Leech Lake dams	433.74	
Examination of Long Prairie River	32.42	
		$11,696.95
Surveys:		
Plant	4,059.09	
Pine River Reservoir	2,886.67	
Pokegama Falls Reservoir	9,428.38	
Leech Lake Reservoir	9,740.15	
Lake Winnibigoshish Reservoir	12,694.09	
At Aitkin	877.94	
Below Pokegama	714.97	
		40,401.29
Lands, easements, etc.:		
Below Pokegama	1,054.34	
Above Pokegama	8,580.36	
		9,634.70
Pine River Reservoir:		
Dikes 1, 3, 4, and 14	9,070.24	
Damage caused by crevasse June 17, 1896	1,733.00	
		11,803.24
Pokegama Falls Reservoir, booms		151.21
Reconstruction of Lake Winnibigoshish Dam:		
Minor buildings	2,993.69	
Plant	9,212.14	
Cofferdam	16,301.40	
Embankments	10,380.42	
Repairs to old foundations	23,213.29	
Concrete	47,701.70	
Cement house	2,311.22	
Log sluice gate	11,366.75	
Tainter gates	15,751.53	
Piers and booms above dam and embankment	5,029.41	
		144,261.55
Reconstruction of Leech Lake Dam:		
Repairs to buildings	750.56	
Miscellaneous	1,415.72	
Plant	5,982.79	
Cofferdams	11,750.73	
Removal of old dam	1,461.04	
Repairs to old foundation	12,705.63	
Concrete	17,906.38	
Stop plank and hoisting gear	1,704.75	
Embankments	277.30	
		53,954.90
Total		271,903.84

The estimate of money required is as follows:

(1) Completion of renewal of Pokegama Falls Dam	$10,000
Renewal of Pine River Dam	125,000
Construction of dikes, Pine River Reservoir	30,000
Contingencies	40,000
	205,000

(1) It is estimated that the sum of $10,000 will be required to make the surveys and investigation of Pine River and Sandy Lake reservoirs as directed in the river and harbor act approved June 13, 1902. This has, therefore, reduced the amount available for the renewal of Pokegama Falls Dam.

Money statement.

July 1, 1901, balance unexpended	$10,445.19
Amount appropriated by river and harbor act approved June 13, 1902	250,000.00
	260,445.19
June 30, 1902, amount expended during fiscal year	10,137.34
July 1, 1902, balance unexpended	250,307.85
July 1, 1902, outstanding liabilities	290.14
July 1, 1902, balance available	250,017.71
Amount (estimated) required for completion of existing project	[a] 205,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	205,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

ABSTRACT OF APPROPRIATIONS.

By act—		By act—	
Approved June 14, 1880	$75,000	Approved July 13, 1892	$60,000
Approved March 3, 1881	150,000	Of August 18, 1894	51,000
Passed August 2, 1882	300,000	Passed June 3, 1896	80,000
Approved July 5, 1884	60,000	Approved March 3, 1899	210,000
Approved August 5, 1886	37,500	Approved June 13, 1902	250,000
Of August 11, 1888	12,000		1,365,500
Approved September 19, 1890	80,000		

REPORT OF MR. R. DAVENPORT, ASSISTANT ENGINEER.

St. Paul, Minn., *June 30, 1902.*

Major: The following report as to the status of the resurvey of the lands affected by reservoir flowage at the headwaters of the Mississippi River, together with the result of the investigation as to the United States titles to the lands shown by the resurvey to be subject to reservoir flowage, as far as completed, is respectfully submitted.

From all surveys and examinations so far made of the reservoir district, the total area more or less affected by the reservoir flowage is estimated at 854 square miles. Of this area the Sandy Lake Reservoir, 55 square miles, was surveyed and the contour for the 8-foot flowage line determined in 1887; Pine River Reservoir, 63 square miles, was resurveyed in 1897 and 1899, the contour, 4 feet above the extreme flowage line, being determined and marked; and of Pokegama, Leech Lake, and Lake Winnibigoshish reservoirs, 393 square miles, were resurveyed in 1899–1900 to the 4-foot contour line above the extreme flowage, leaving of the last three mentioned reservoirs 343 square miles of the flowage area to be examined.

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[a] Required for work as contemplated in the river and harbor acts of March 3, 1899, and June 13, 1902.

Of the lands resurveyed, 254 square miles are in the Chippewa Indian Reservation, the remaining 202 square miles being private lands, etc. The Indian reservation lands are included in 1,985 separate tracts, containing 46,470.31 acres of land affected by flowage.

Of the area remaining to be resurveyed, 245 square miles are within the Indian reservation limits and 98 square miles are private lands, etc.

Since the completion, in the spring of 1901, of the maps of the resurveyed lands (the maps of Sandy Lake Reservoir were replotted and made uniform with those of the more recent surveys for the purpose of reexamination), investigation has been made as far as possible as to the ownership of all of the lands affected, with the result that 26 tracts of land, containing 269 acres, found to be public lands of the United States, were reserved for reservoir purposes by Presidential order, and 78 tracts of land, containing 1,377.32 acres, belonging to the State of Minnesota, have been listed and filed with the State auditor, as subject to reservoir flowage, under the act of the legislature of the State of Minnesota approved November 18, 1881.

The investigation, as far as completed, leaves undetermined the status as to the right of flowage on tracts of reservoir lands, as follows:

	No. of tracts.	Acres.
Sandy Lake Reservoir, survey of 1887	31	284.22
Pine River Reservoir, resurvey of 1897 and 1899	118	1,693
Pokegama, Leech Lake, and Lake Winnibigoshish reservoirs, resurvey of 1899-1900	256	4,747.04
Total	405	6,724.26

The land here noted for Pine River reservoir flowage includes 82 acres estimated as required for the 16 dikes built and proposed.

Owing to the original survey having been imperfect, further examination and comparison of the flowage rights so far obtained by the United States with the flowage limits determined by the resurvey will be necessary before all of the additional areas that will be required for the Pine River reservoir can be accurately determined.

Very respectfully, your obedient servant,

R. Davenport,
Assistant Engineer.

Maj. R. L. Hoxie,
Corps of Engineers.

Z 3.

OPERATING AND CARE OF RESERVOIRS AT HEADWATERS OF MISSISSIPPI RIVER.

The two main reservoirs, Lake Winnibigoshish and Leech Lake, were in operation during the past fiscal year, but the latter, being only partially rebuilt, could only store a moderate quantity of water.

The distributing reservoir at Pokegama Falls and the reservoirs at Pine River and Sandy Lake have been operated as usual, but on account of their small size their effect has been slight except as they assisted in the floating of loose logs. The full operation of the reservoirs will not be resumed until the reconstruction of Leech Lake dam is completed, which it is expected will be during the season of 1902.

The reconstruction of the Pokegama Falls dam can be arranged so as not to materially reduce the usefulness of the reservoirs while the work is in progress.

The effect of the reservoirs, when in full operation, is to increase the stage of water in the Mississippi River at St. Paul during the low-water period in late summer and fall of the year by 12 to 18 inches.

During the year the embankment at Lake Winnibigoshish dam was further protected by extending the revetment over a portion that could not be reached before on account of the water in the lake not being sufficiently low.

The cofferdam at Leech Lake dam was raised 1 foot to provide a greater storage capacity and facilitate the operation of the completed portion of the dam.

At Sandy Lake the caving bank just below the dam was protected by a revetment of brush fascines and stone riprap, the space revetted being 138 feet by 40 feet. Three hundred and thirty brush fascines were used. Cost, exclusive of dam tenders' services, $81.28.

The new house for dam tenders at Lake Winnibigoshish dam, commenced last year, was completed and necessary repairs were made to the other buildings. New foundations were built for the dam tender's house at Sandy Lake dam and the house replastered and repaired where necessary.

Expenditures, exclusive of outstanding liabilities, to June 30, 1901	$140,081.15
Amount expended during fiscal year ending June 30, 1902, exclusive of outstanding liabilities	17,576.47

Distribution of liabilities incurred during fiscal years 1898–1902.

	Amount.				
	1898.	1899.	1900.	1901.	1902.
Pokegama Falls dam:					
Operating	$1,697.42	$1,704.08	$1,804.23	$1,704.85	$1,640.28
Repairs	144.62	....	337.45	....	....
Land condemnation	207.40	....	....	....	....
Total	2,049.44	1,704.08	2,141.68	1,704.85	1,640.28
Leech Lake dam:					
Operating	1,251.02	1,154.45	1,364.11	875.20	1,275.68
Repairs	163.95	....	....	....	9.45
Total	1,414.97	1,154.45	1,364.11	875.20	1,285.13
Lake Winnibigoshish dam:					
Operating	1,734.67	966.10	435.72	722.42	1,421.46
Repairs	158.41	....	[a] 5,384.12	[b] 3,517.70	[c] 2,088.31
Buildings and grounds	....	....	....	....	2,228.11
Total	1,893.08	966.10	5,819.84	4,240.12	5,737.88
Pine River dam:					
Operating	1,770.41	1,235.28	1,252.00	1,269.75	1,164.92
Repairs	368.05	188.99	....	....	....
Crevasse	1,329.72	....	....	....	....
Total	3,468.18	1,424.27	1,252.00	1,269.75	1,164.92
Sandy Lake dam:					
Operating	2,430.44	1,745.91	1,581.02	1,535.44	1,634.12
Repairs	671.92	[d] 999.15	....	....	307.27
Total	3,102.36	2,745.06	1,581.02	1,535.44	1,941.39
Superintendence, contingencies, and St. Paul office	3,184.17	1,747.75	3,348.40	2,643.65	4,329.22
Operating steamboat General Poe	1,692.22	....	....	....	....
Hydrological expenses	1,109.99	[e] 100.00	[e] 120.00	....	....
Operating expenses applicable to all reservoirs	1,166.38	2,539.15	1,069.99	2,187.04	1,477.65
Road between Leech Lake and Lake Winnibigoshish	407.01	1,719.16	2,652.96	2,199.73	....
Total	19,487.80	14,100.02	19,350.00	16,655.78	17,576.47

[a] Repairing dike.
[b] Repairing dike, $3,117.70.
[c] Repairing dike, $1,078.57.
[d] Telephone line.
[e] Gauge readings at Deer River.

For commercial statistics reference must be made to the reports upon the improvement of the Mississippi River.

Summary of expenditures during the fiscal year ending June 30, 1902.

Services	$11,961.89
Supplies	235.31
Materials	1,139.64
Traveling expenses	304.08
Office expenses and contingencies	3,935.55
Total	17,576.47

Money statement.

July 1, 1901, balance unexpended	$12,863.42
Amount allotted August 12, 1901	12,948.12
	25,811.54
June 30, 1902, amount expended during fiscal year	17,576.47
July 1, 1902, balance unexpended	8,235.07
July 1, 1902, outstanding liabilities	675.07
July 1, 1902, balance available	7,560.00

ABSTRACT OF TOTAL LIABILITIES INCURRED IN EACH FISCAL YEAR.

During fiscal year ending June 30—		During fiscal year ending June 30—	
1895	$6,416.19	1901	$18,498.12
1896	30,800.15	1902	14,500.00
1897	35,180.41	Amount available June 30, 1902	7,560.00
1898	19,487.80		
1899	14,100.02		
1900	19,350.00	Total	165,892.69

ABSTRACT OF ALLOTMENTS.

January 25, 1895	$17,590.00	August 4, 1898	$16,347.80
June 15, 1895	18,852.91	August 15, 1899	12,720.02
June 20, 1896	5,000.00	July 16, 1900	20,610.00
July 24, 1896	23,471.98	September 28, 1900	7,000.00
For repairs to Pine River Reservoir	7,481.86	August 12, 1901	12,948.12
August 4, 1897	23,870.00	Total	165,892.69

Z 4.

IMPROVEMENT OF CHIPPEWA RIVER, INCLUDING YELLOW BANKS, WISCONSIN.

The approved project and report of progress of the work up to June 30, 1901 will be found in the Annual Report of the Chief of Engineers for 1902, Part I, page 376.

Amount expended to June 30, 1902, $201,743.85.

Owing to the limited amount of funds available no work was done during the past fiscal year.

The river and harbor act approved June 13, 1902, contains a provision abandoning further improvement of this river.

Money statement.

July 1, 1901, balance unexpended	$63.77
June 30, 1902, amount expended during fiscal year	57.62
July 1, 1902, balance unexpended	6.15
July 1, 1902, outstanding liabilities	6.15

ABSTRACT OF APPROPRIATIONS.

By act—		By act—	
Approved August 14, 1876	$10,000	Of August 11, 1888	$10,000
Approved June 8, 1878	10,000	Approved September 19, 1890	10,000
Approved March 2, 1879	8,000	Approved July 13, 1892	5,000
Approved June 14, 1880	10,000	Of August 18, 1894	10,000
Approved March 3, 1881	10,000	Passed June 3, 1896	10,000
Passed August 2, 1882	65,000	Approved March 3, 1899	10,000
Approved July 5, 1884	15,000		
Approved August 5, 1886	18,750	Total	201,750

COMMERCIAL STATISTICS.

Comparative statement of lumber, laths, shingles, pickets, and logs, 1901.

Lumber	feet B. M.	24,763,202
Laths	number	12,452,750
Shingles	do	8,259,300
Pickets	do	34,880
Total tonnage, exclusive of loose logs	tons	62,229
Loose logs	feet B. M.	86,535,000

But one steamboat has plied regularly on the river since 1885. This boat, the *Phil Shekel* (108 tons burden and 2 feet draft), ran from the mouth to Dunville, about halfway between the mouth and Eau Claire, to assist the Knapp, Stout & Co. company's rafts in floating down river. Her passengers and freight were confined entirely to the company's rafting business.

Z 5.

IMPROVEMENT OF ST. CROIX RIVER, WISCONSIN AND MINNESOTA.

The approved project and the report of progress of the work up to June 30, 1901, will be found in the report of the Chief of Engineers for 1902, page 376.

The expenditures during the fiscal year were $274.08.

Owing to the limited amount of funds available no work was done during the fiscal year beyond the care of boats and property, except during the months of July, August, September, and October, 1901, when gauges were established and read daily at Osceola and Nevers Dam, Wisconsin, in connection with the formulation of regulations for navigating the river.

The controversy which commenced in 1897 between the logging and the steamboat interests is still continued. In 1900 and 1901 regulations to govern the use of the river were issued by the Secretary of War. (See Annual Report of the Chief of Engineers for 1901, p. 2330.)

Regulations for the season of 1902 are under consideration. During the season of 1901 the flow of water in the river was so controlled that the regular operation of steamboats between Taylors Falls and Stillwater, Minn., was not practicable.

In the vicinity of Hudson, Wis., which was improved in 1889–1891 by dredging and the construction of training dams, new bars have formed in the channel which materially interfere with the movements of towboats and rafts at low water. The training dams are damaged in places and require repairing to keep up their efficiency.

* * * In 1904 an increased appropriation will be needed.

Money statement.

July 1, 1901, balance unexpended	$891.77
Amount appropriated by river and harbor act approved June 13, 1902	2,000.00
	2,891.77
June 30, 1902, amount expended during fiscal year	274.08
July 1, 1902, balance unexpended	2,617.69
Outstanding liabilities	.25
July 1, 1902, balance available	2,617.44
Amount (estimated) required annually by existing project	1,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	5,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

ABSTRACT OF APPROPRIATIONS.

By act—		By act—	
Approved June 18, 1878	$10,000	Approved September 19, 1890	$8,000
Approved March 3, 1879	8,000	Approved July 13, 1892	8,000
Approved June 14, 1880	10,000	Of August 18, 1894	4,000
Approved March 3, 1881	8,000	Passed June 3, 1896	15,000
Passed August 2, 1882	30,000	Approved March 3, 1899	9,000
Approved July 5, 1884	9,000	Approved June 13, 1902	2,000
Approved August 5, 1886	7,500		
Of August 11, 1888	10,000	Total	138,500

COMMERCIAL STATISTICS.

* * * * * * *

Rafted logs and lumber, 1901.

Rafted logs towed out of St. Croix River (estimated)	feet B. M.	251,448,220
Rafted lumber towed out of St. Croix River:		
Lumber	do	161,800,000
Shingles	number	40,050,000
Laths	do	38,550,000
Pickets	do	75,000
Total tonnage, exclusive of loose logs	tons	1,216,795
Loose logs run on river above Stillwater	feet B. M.	326,448,220
	tons	1,132,569

Z 6.

IMPROVEMENT OF MINNESOTA RIVER, MINNESOTA.

The approved project and the report of progress of the work up to June 30, 1902, will be found in the report of the Chief of Engineers for 1902, Part I, page 377.

No work was done during the past year.

Amount expended to June 30, 1901, on all parts of the river, $132,193.34.

Money statement.

July 1, 1901, balance unexpended	$306.66
July 1, 1902, balance unexpended	306.66
Amount (estimated) required annually by existing project	500.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	500.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

ABSTRACT OF APPROPRIATIONS.

By act—	
Approved March 3, 1867	$37,500
Approved July 11, 1870	10,000
Approved March 3, 1871	10,000
Approved June 10, 1872	10,000
Passed March 3, 1873	10,000
Approved June 23, 1874	10,000
Approved March 3, 1875	10,000
Approved August 14, 1876	$10,000
Approved June 18, 1878	10,000
Of August 11, 1888	10,000
Passed June 3, 1896	4,000
Approved March 3, 1899	1,000
Total	132,500

COMMERCIAL STATISTICS.

* * * * * * *

There was no traffic on the river during the seasons of 1891, 1892, 1893, 1894, and 1895, as steamboats could not at all times pass the bar at the mouth of the river. Since 1896 there has been no traffic on the river other than occasional excursions by boats from St. Paul, Hastings, Stillwater, and other points, of which excursions statistics have not been obtainable by this office.

Z 7.

IMPROVEMENT OF RED RIVER OF THE NORTH, MINNESOTA AND NORTH DAKOTA.

RED RIVER OF THE NORTH.

The approved project and the report of progress of the work up to June 30, 1901, will be found in the Report of the Chief of Engineers for 1902, Part I, page 378.

The expenditures during the fiscal year 1902 were $841.52. Owing to the limited amount of funds available no work has been done during the year beyond care of plant at Grand Forks, N. Dak.

The dredging fleet was generally repaired in 1899 and the boats and machinery are in good working condition, except that the steamer

Ogama will require general repairs on the hull and a new boom will be necessary on the dredge *Otter Tail* before work can be resumed. Partial recalking and painting of the boats will also be necessary. Estimated cost of repairs: Hull of steamer *Ogama*, $800; new boom for dredge *Otter Tail*, $350; partial recalking and painting of fleet, $400; total, $1,550.

Pilots of steamboats operating on the Red River during the season of 1901 report the appearance of a number of new bars, both north and south of Grand Forks, which materially interfere with navigation at low-water stages.

The channel at the land slide at Grand Forks, caused by the construction of the Northern Pacific Railway embankment, is also reported to be in bad shape for the movement of boats at low water.

RED LAKE RIVER.

The expenditures during the fiscal year 1902 were $449.09.

Owing to the limited amount of funds available no work has been done during the past year beyond care of plant at Thief River Falls, Minn.

The derrick fleet at Thief River Falls is in serviceable condition but will require calking and painting before work can be resumed. The work heretofore done has consisted in the removal of snags, bowlders, and overhanging trees between Thief River Falls and High Landing, Minn. This section of the river can again be worked over to advantage, as new obstructions of that nature are reported to have accumulated.

The river in the vicinity of East Grand Forks has been partially cleared of obstructions for about 8 miles above its mouth, and the removal of obstructions, mainly large snags and overhanging trees, can be advantageously continued to Fishers Landing, Minn., about 30 miles from the mouth.

The stage of water in Red Lake River was favorable for navigation throughout the entire season of 1901, but the movement of steamboats was much interfered with by the unregulated running of loose logs from Red Lake for the use of the sawmills at Thief River Falls, Red Lake Falls, Crookston, and East Grand Forks.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended	$1,877.01
Amount appropriated by river and harbor act approved June 13, 1902	10,000.00
	11,877.01
June 30, 1902, amount expended during fiscal year	1,290.61
July 1, 1902, balance unexpended	10,586.40
July 1, 1902, outstanding liabilities	183.84
July 1, 1902, balance available	10,402.56
Amount (estimated) required for completion of existing project	6,320.00
Amount that can be profitably expended in fiscal year ending June 30, 1894, for maintenance of improvement in addition to the balance unexpended July 1, 1902	6,320.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

ABSTRACT OF APPROPRIATIONS.

By act—	
Approved August 14, 1876	$10,000
Approved June 18, 1878	30,000
Approved March 3, 1879	25,000
Approved June 14, 1880	20,000
Approved March 3, 1881	18,000
Passed August 2, 1882	10,000
Approved July 5, 1884	10,000
Approved August 5, 1886	50,000
Of August 11, 1888	20,000
Approved September 19, 1890	$25,000
Approved July 13, 1892	25,000
Of August 18, 1894	15,000
Passed June 3, 1896	20,000
Approved March 3, 1899	25,000
Approved June 13, 1902	10,000
Total	313,000

COMMERCIAL STATISTICS.

Red River of the North, 1901.

Two boats from 23 to 100 tons burden and from 20 to 30 inches draft are running on the river. The 2 boats have a combined fleet of 10 barges. Total freight carried, 22,660 tons.

Red Lake River, 1901.

Freight	tons	482
Passengers	number	1,117
Logs run	feet B. M.	74,000,000

Three steamboats, from 24 to 50 tons burden and 20 to 30 inches draft, are engaged in the river and lake traffic, and 5 steamboats, from 50 to 150 tons burden and 36 inches to 42 inches draft, are engaged exclusively in the lake traffic.

Z 8.

IMPROVEMENT OF WARROAD HARBOR AND WARROAD RIVER, MINNESOTA.

The approved project and report of progress of the work up to June 30, 1901, will be found in the Report of the Chief of Engineers for 1902, Part I, page 379. No work was done during the past fiscal year.

The river and harbor act approved June 13, 1902, appropriates $45,000 for "Improving Warroad Harbor and Warroad River, Minn." It is expected to expend this amount, together with the unexpended balance from the last appropriation, in the construction of a dredge and in dredging Warroad harbor and river, as indicated in report submitted June 21, 1900, and published in House Doc. No. 92, Fifty-sixth Congress, second session.

Amount expended to June 30, 1902, $596.63.

Money statement.

July 1, 1901, balance unexpended	$2,403.37
Amount appropriated by river and harbor act approved June 13, 1902	45,000.00
July 1, 1902, balance unexpended	47,403.37

ABSTRACT OF APPROPRIATIONS.

By act approved March 3, 1899	$3,000
By act approved June 13, 1902	45,000
Total	48,000

Z 9.

SURVEY OF RED LAKE AND RED LAKE RIVER, MINNESOTA.

The approved project and report of the progress of the work up to June 30, 1901, will be found in the Report of the Chief of Engineers for 1902, Part I, page 380.

Amount expended to June 30, 1902	$4,989.85

Hydrological measurements were continued until August 30, 1901, when operations were suspended on account of exhaustion of funds.

The river and harbor act approved June 13, 1902, provides for the continuation of this survey.

Table of run-off of Red Lake River above the mouth of Thief River (about 100 miles below Red Lake).

Month.	Cubic feet.	Month.	Cubic feet.
1899.		1900.	
May	2,572,796,736	August	2,744,236,800
June	2,953,722,240	September	4,492,972,800
July	3,151,008,000	October	5,311,931,200
August	2,039,990,400	November	3,783,024,000
September	1,942,444,800	December	2,683,324,800
October	1,921,968,000		
November	1,378,512,000	1901.	
December	1,275,264,000	January	2,083,536,000
		February	1,871,195,040
1900.		March	2,141,683,200
January	1,181,088,000	April	5,455,814,400
February	1,085,616,000	May	4,054,320,000
March	1,174,176,000	June	3,320,006,400
April	1,578,224,000	July	3,765,744,000
May	1,087,344,000	August	3,075,926,400
June	1,126,336,000		
July	1,131,840,000	Total for 28 months	70,434,045,216

Money statement.

July 1, 1901, balance unexpended	$409.95
June 30, 1902, amount expended during fiscal year	399.80
July 1, 1902, balance unexpended	10.15
July 1, 1902, outstanding liabilities	10.15

ABSTRACT OF APPROPRIATIONS.

By act approved March 3, 1899	$5,000

Z 10.

SURVEY OF OTTER TAIL LAKE AND OTTER TAIL RIVER, MINNESOTA.

The approved project and report of progress of the work up to June 30, 1901, will be found in the Report of the Chief of Engineers for 1902, Part I, page 380.

Amount expended to June 30, 1902	$2,146.66

Measurements of the run-off of the streams tributary to Otter Tail Lake were continued during the past year, and the river and harbor act approved June 13, 1902, provides for the continuation of the survey.

Table of run-off at outlet of Otter Tail Lake from May 1, 1899, to June 30, 1902, inclusive.

Month.	Cubic feet.	Month.	Cubic feet.
1899.		1901.	
May	636,681,600	January	461,721,600
June	1,439,277,984	February	343,353,600
July	1,739,491,200	March	393,638,400
August	1,289,260,800	April	519,091,200
September	1,017,964,800	May	538,617,600
October	779,068,800	June	593,654,400
November	849,657,600	July	939,340,800
December	810,000,000	August	1,059,004,800
		September	732,412,800
1900.		October	506,908,800
January	629,424,000	November	564,019,200
February	568,512,000	December	436,838,400
March	583,113,600		
April	527,938,128	1902.	
May	507,945,600	January	430,185,600
June	347,328,000	February	347,328,000
July	260,841,600	March	444,700,800
August	354,585,600	April	376,704,000
September	402,451,200	May	939,427,200
October	518,140,800	June	1,582,588,800
November	531,273,600		
December	530,323,200	Total for 38 months	25,582,816,112

Money statement.

July 1, 1901, balance unexpended	$1,464.39
June 30, 1902, amount expended during fiscal year	611.05
July 1, 1902, balance unexpended	853.34
July 1, 1902, outstanding liabilities	46.50
July 1, 1902, balance available	806.84

ABSTRACT OF APPROPRIATION.

By act approved March 3, 1899	$3,000

Z 11.

SURVEY OF BIG STONE LAKE AND LAKE TRAVERSE, MINNESOTA AND SOUTH DAKOTA.

The approved project and report of progress of the work up to June 30, 1901, will be found in the Report of the Chief of Engineers for 1902, Part I, page 381.

Amount expended to June 30, 1902	$1,869.31

During the past year measurements of the run-off of the Minnesota and Whetstone rivers were continued.

The river and harbor act approved June 13, 1902, provides for the continuation of this survey.

Table of run-off of the Minnesota River below the mouth of the Whetstone River.

Month.	Cubic feet.
1899.	
March	153,143,000
April	317,002,000
May	208,047,000
June	516,309,000
July	88,237,000
August	107,514,000
September	51,159,000
October	89,757,000
November	63,504,000
December	65,186,000
1900.	
January	88,940,000
February	62,770,000
March	139,320,000
April	318,808,000
May	64,065,000
June	18,116,000
July	14,114,000
August	70,026,000
September	67,344,000
October	78,028,000
November	71,133,000
December	64,178,000
1901.	
January	70,433,000
February	61,249,000
March	178,966,000
April	298,175,000
May	86,906,000
June	34,027,000
July	12,433,000
August	10,276,000
September	21,069,000
October	37,670,000
November	38,025,000
December	60,558,000
1902.	
January	74,045,000
February	55,469,000
March	59,789,000
April	68,796,000
May	84,283,000
June	33,748,000
Total for 40 months	4,002,617,000

Money statement.

July 1, 1901, balance unexpended	$3,568.18
June 30, 1902, amount expended during fiscal year	437.49
July 1, 1902, balance unexpended	3,130.69
July 1, 1902, outstanding liabilities	15.25
July 1, 1902, balance available	3,115.44

ABSTRACT OF APPROPRIATION.

By act approved March 3, 1899	$5,000

APPENDIX A A.

IMPROVEMENT OF MISSOURI RIVER AT AND ABOVE SIOUX CITY, IOWA.

REPORT OF CAPT. H. M. CHITTENDEN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Missouri River between Stubbs Ferry, Montana, and the lower limits of Sioux City, Iowa.
2. Upper Missouri River by snagging.

United States Engineer Office,
Sioux City, Iowa, July 1, 1902.

General: I have the honor to transmit herewith report upon the works of river and harbor improvement, this district, for the fiscal year ending June 30, 1902.

Very respectfully, your obedient servant,

H. M. Chittenden,
Captain, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

A A 1.

IMPROVEMENT OF MISSOURI RIVER BETWEEN STUBBS FERRY, MONTANA, AND THE LOWER LIMITS OF SIOUX CITY, IOWA.

APPROPRIATION.

The river and harbor act of June 13, 1902, contains the following appropriation for work on the Missouri River between Stubbs Ferry, Montana, and Sioux City, Iowa:

> Improving Missouri River at Sioux City, Iowa, and above to Stubbs Ferry, Montana: Continuing improvement, including snagging, one hundred thousand dollars, to be expended at such localities and in such amounts as the Secretary of War shall determine

This appropriation has not yet been allotted to localities.

OPERATIONS.

Carroll to Sioux City.—Work has been done at several localities, as described below:

Bismarck Harbor.—Original condition, projects, and work done to June 30, 1901, are described in the Annual Report of the Chief of Engineers for 1900, pages 444, 445, 2860, and 2861, and for 1901, page 2374.

No new work was done during the fiscal year. The group of dikes constructed on the right bank in 1895 was repaired at a cost of $350, and repairs were made to the revetment on the right bank at a cost of $294, and to the revetment on the left bank at a cost of $106.

The amount expended during the fiscal year ending June 30, 1902, was $1,005.09, of which $750 was for maintenance.

A map of the locality accompanied my annual report for 1900.

Pierre and Fort Pierre.—Original condition, projects, and work done to June 30, 1901, are described in the Annual Report of the Chief of Engineers for 1900, pages 445, 446, 2861, and 2862, and for 1901, page 2375.

No work was done at this locality during the fiscal year except repairs to the revetment at the head of Marion Island, at a cost of $240.75. Eighty cubic yards of rock were used on this work.

The amount expended during the fiscal year ending June 30, 1902, was $1,149.55, of which $290.75 was for maintenance.

A map of the locality accompanied my annual report for 1900.

Yankton.—Original condition, projects, and work done to June 30, 1901, are described in the Annual Report of the Chief of Engineers for 1900, pages 446, 447, and 2862, and for 1901, page 2375.

No work was done at this locality during the fiscal year except some minor repairs to the dikes, costing $141.

The amount expended during the fiscal year ending June 30, 1902, was $279.30, of which $141 was for maintenance.

A map of the locality accompanied my annual report for 1900.

Elkpoint.—Original condition, projects, and work done to June 30, 1901, are described in the Annual Report of the Chief of Engineers for 1900, pages 447, 2862, and 2863, and for 1901, page 2375.

No work was done at this locality during the fiscal year except the repair of a small break in the revetment, at a cost of $809.70.

A mattress 200 feet long and 40 feet wide was woven. Sixty-one cords of brush and 105 cubic yards of rock were used in the work.

.The amount expended during the fiscal year ending June 30, 1902, was $5,844.60, of which $909.70 was for maintenance. A large portion of the above amount was expended in payment of freight charges incurred in previous years.

A map of this locality accompanied my annual report for 1900.

Opposite Sioux City to opposite Elkpoint.—Original condition, projects, and work done to June 30, 1901, are described in the Annual Report of the Chief of Engineers for 1900, pages 447, 448, and 2863, and for 1901, page 2376.

No work was done at this locality during the fiscal year except minor repairs to revetment, costing $85.80.

The amount expended during the fiscal year ending June 30, 1902, was $3,601.57, of which $185.80 was for maintenance.

A large portion of the above amount was expended in payment of freight charges incurred in previous years.

A map of this locality accompanied my annual report for 1900.

Sioux City.—Original condition, projects, and work done to June 30, 1901, are described in the Annual Report of the Chief of Engineers for 1900, pages 448, 449, 2863, and 2864, and for 1901, page 2376.

No work was done at this locality during the fiscal year except repairs to dikes, costing $224.60, and repairs to revetment, costing $60.40.

The amount expended during the fiscal year ending June 30, 1902, was $5,980.71, of which $485 was for maintenance. A large portion of the above amount was expended in payment of freight charges incurred in previous years.

A map of this locality accompanied my annual report for 1900.

Ice harbors.—Original condition, projects, and work done to June 30, 1898, are described in the Annual Reports of the Chief of Engineers for 1895, page 2219; for 1896, pages 1867 and 1868; for 1897, page 2184, and for 1898, page 1846.

There have been no expenditures and no work since 1898.

Gauges.—Permanent gauges were maintained throughout the year at Townsend and Fort Benton, Mont.; at Bismarck, N. Dak.; at Fort Pierre, S. Dak., and at Sioux City, Iowa, on the Missouri River, and at Glendive, Mont., on the Yellowstone River. Readings were taken on all these gauges twice daily throughout the year.

FUTURE WORK.

The public work on the entire Missouri River has been consolidated under a single office. The discontinuance of the Missouri River Commission and the greatly reduced appropriations, as compared with former years, for both the upper and lower river, indicate an intention on the part of Congress to abandon the river altogether in the near future. In its final report the Missouri River Commission dealt with the work and requirements of the lower river. Inasmuch as there will not be another river and harbor bill for two years, and therefore no need of present estimates for Congress to act upon, such estimates are omitted from this report. Before the rendition of the annual report for 1903, the officer in charge will be prepared to submit a comprehensive statement of the conditions of the entire river, and the advisability or nonadvisability of further work upon it, together with estimates, if such work is considered necessary.

Money statement.

July 1, 1902, balance unexpended [a]	$24,153.82
Amount appropriated by river and harbor act approved June 13, 1902	100,000.00
	124,153.82
June 30, 1902, amount expended during fiscal year	17,886.22
July 1, 1902, balance unexpended	106,267.60
July 1, 1902, outstanding liabilities	1,129.53
July 1, 1902, balance available	105,138.07
Amount (estimated) required for completion of existing project	Indefinite.
Amount received from Maj. W. L. Marshall, U. S. Army, September 16, 1901, on account of transfer of file case	$15.00
Restoration of amounts dropped from 1901 report $212.39 less amount previously expended, $4.37; corrected amount	208.02
Total	223.02

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[a] Increase of $223.02 over amount stated in 1901 report explained as follows:

APPROPRIATIONS.

The appropriations and allotments, exclusive of those for snagging, for the Upper Missouri River have been as follows:

1876	$20,000	1890	[b]$300,000
1878	42,500	1892	[c]150,000
1879	60,000	1894	110,000
1880	43,000	1895	40,000
1881	66,000	1896	235,000
1882	[a]115,000	1899	205,000
1884	140,000	1902	100,000
1886	60,000		
1888	200,000	Total	1,886,500

In addition to the above amounts, about $60,000 from the appropriations for the survey of the river from Fort Benton to the mouth was spent on the part above Sioux City.

A A 2.

IMPROVEMENT OF UPPER MISSOURI RIVER BY SNAGGING.

Original condition, project, and work done to June 30, 1901, are described in the Annual Report of the Chief of Engineers for 1901, pages 457, 2391, and 2392, and in previous reports.

No work has been done during the fiscal year except the care of the plant. The boats have been laid up at the Sioux Ice Harbor.

Money statement.

July 1, 1901, balance unexpended	[d]$1,619.59
June 30, 1902, amount expended during fiscal year	1,170.68
July 1, 1902, balance unexpended	448.91
July 1, 1902, outstanding liabilities	142.53
July 1, 1902, balance available	306.38

APPROPRIATIONS FOR IMPROVING UPPER MISSOURI RIVER BY SNAGGING.

Allotments made from appropriations of 1890 and 1892, for improvement of Upper Missouri River	$193,073.53
March 3, 1893	50,000.00
August 18, 1894	50,000.00
June 3, 1896	50,000.00
March 3, 1899	50,000.00
Total	393,073.53

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[a] $2,832.42 of this transferred to work below Sioux City.

[b] $192,912 of this afterwards allotted to snagging.

[c] $163.51 of this afterwards allotted to snagging.

[d] Increase of $11.88 over amount stated in 1901 report; restoration of amount dropped from 1901 report.

COMMERCIAL STATISTICS.

During the calendar year 1901 the number of boats engaged in carrying freight and passengers, exclusive of those which during the year did only a ferriage business, is 8, with a total tonnage of 756. The freight and passengers carried by them are as follows:

Brick and tiling, and stone	tons..	660
Coal and wood	do...	7,872
Grain	do...	12,117
Lumber	do...	5,032
Lime and cement	do...	91
General merchandise and miscellaneous	do...	8,922
Live stock	do...	2,655
Passengers	number..	756

A new line, consisting of two small steamboats, plying short distances above and below Bismarck, was established in 1901 by the Bismarck, Washburn and Great Falls Railroad Company.

Traffic by river reaches.

Year.	River reaches between—	Packages and bulk freight.	Passengers.	Live stock.
1901	Sioux City and Fort Yates	13,402	64	11,096
	Fort Yates and Fort Berthold	21,292	204	158
	Great Falls and Stubbs Ferry	....	488	....

List of steamers and gasoline boats plying on the Missouri River between Sioux City, Iowa, and Stubbs Ferry, Montana, during the year 1901.

Name.	When built.	Dimensions.			Tonnage.	Owner or manager.
		Length.	Breadth.	Depth.		
		Feet.	*Feet.*	*Feet.*		
Annie Austin [a]	1898	61	15.5	2.5	19	H. I. Brown, Ponca, Nebr.
Alice [a]	1900	61.5	16.5	2.5	16	Pearson & Demar, Ionia, Nebr.
Uella May [a]	1900	59	18.5	2.8	18	C. T. Oldham, Platte, S. Dak.
Pride of the West [a]	1899	40.5	22.5	2.5	16	A. B. Millick, St. Helena, Nebr.
Josie L. K.	1884	71.5	14.5	3.5	27	Yankton Bridge and Ferry Co., Yankton, S. Dak.
South Dakota	1899	137.5	19.4	4.5	96	Joseph Leach, Runningwater, S. Dak.
Little Maud	1900	105	23	4.5	89	Do.
Myrtle [a]	1896	32	7	3	7	E. E. Lindsay, Wheeler, S. Dak.
Little Anna [a]	1900	66	19	2.5	23	Joseph Rudloff, Tower, Nebr.
Eda [a]	1900	39	24	2.5	22	F. J. Whitthaus, Wagner, S. Dak.
Nellie L. [a]	1900	60	13.5	2.2	15	Dennis Moran, Lake Andes, S. Dak.
Iowa [a]	1897	91	18	2.7	48	J. W. Sanford, Chamberlain, S. Dak.
Capitola Butt	1885	97.7	25.5	3.7	67	Do.
Jim Leighton	1895	119.5	30.16	3.6	110	Chicago and Northwestern Railway Co., Pierre, S. Dak.
Scotty Philip [a]	1900	106.6	23.8	3.5	69	Missouri River Transportation Co., Pierre, S. Dak.
Lizzie Reid	1896	66	22	3.5	46	J. A. Lake, Gettysburg, S. Dak.
Cannon Ball [a]	1895	71	14	3.2	[b] 20	J. D. Leach, Cannon Ball, N. Dak.
F. Y. Batchelor	1878	178.6	31	4	313	I. P. Baker, Bismarck, N. Dak.
Imelda	1892	90	17	2	30	Do.
Bismarck [a]	1896	120	21	4	93	Do.
Peerless [a]	1897	83	21	3.5	[b] 50	Do.
Expansion	1900	109	25	4	[b] 90	B., W. and Gt. F. R. R. Co., Bismarck, N. Dak.
Washburn	1901	100	25	4	57.4	
Vermillion [a]	1901	51	20.5	2.5	146	Ludwig Rostad, Vermillion, S. Dak.
Swallow [a]	1898	48	10.5	4.5	17	Hutton & Brown, Springfield, S. Dak.
Rose	1886	44	10	2.9	[b] 9	N. Hilger, Helena, Mont.

[a] Gasoline boat.

Estimated.

Dates of ice closings and openings on the Missouri River at and above Sioux City, Iowa, and on the Yellowstone River at Glendive, Mont., 1900–1901.

[Continued from page 2395, Annual Report of the Chief of Engineers for 1901.]

Locality.	Closing.	Opening.
Montana:		
Townsend	Dec. 14, 1901	Feb. 25, 1902
Fort Benton	Jan. 23, 1902	Do.
Glendive	Dec. 14, 1901	Mar. 23, 1902
North Dakota: Bismarck	Dec. 13, 1901	Apr. 5, 1902
South Dakota: Pierre	Dec. 14, 1901	Mar. 12, 1902
Iowa: Sioux City	Dec. 17, 1901	Mar. 8, 1902

APPENDIX B B.

IMPROVEMENT OF CUMBERLAND RIVER, TENNESSEE AND KENTUCKY, AND OF OBION AND FORKED DEER RIVERS, TENNESSEE.

REPORT OF LIEUT. COL. M. B. ADAMS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Obion and Forked Deer Rivers, Tennessee.
2. Cumberland River, Tennessee and Kentucky, below Nashville, Tennessee.
3. Removing sunken vessels or craft obstructing or endangering navigation.

ENGINEER OFFICE, UNITED STATES ARMY,
Nashville, Tenn., July 8, 1902.

GENERAL: I have the honor to transmit herewith the annual report upon the river improvements in my charge for the fiscal year ending June 30, 1902.

Very respectfully, your obedient servant,

M. B. ADAMS,
Lieut. Col., Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

B B 1.

IMPROVEMENT OF OBION AND FORKED DEER RIVERS, TENNESSEE.

A detailed description of the Obion River, plans for improvement, previous project, and modification of same, are given in the Annual Report of the Chief of Engineers, 1896, page 1897 et seq., and same report for 1897, page 2217 et seq., and of the Forked Deer River, page 1900 et seq., id.

During the past fiscal year the following work was done:

Snags removed	1,411
Snags cut	2,868
Logs cut	1,932
Leaning trees cut	2,668
Trees deadened	784

The snagging party commenced work July 22 at Dyersburg, on North Fork, passing thence to mouth of main stream into Obion River, thence to Obion, Tenn., about 88 miles, closing operations October 22, 1901. Total amount expended during fiscal year ending June 30, 1902, was $2,242.57. The only practicable method of carrying on the work has been by hired labor.

The balances remaining to the credit of the separate streams, viz, $119.70 on Obion River, and $93 on Forked Deer River, have been passed to the credit of the appropriation for improving Obion and Forked Deer Rivers, in accordance with river and harbor act of June 13, 1902. Said act also appropriated $4,500 for Obion and Forked Deer rivers, which will be expended in accordance with approved project.

It is expected to send out a snagging party as soon as practicable.

During the calendar year ending December 31, 1901, the commerce so far as could be ascertained aggregated 26,717 tons, having an estimated value of $71,521.

Money statement.

July 1, 1901, balance unexpended	[a]$2,455.27
Amount appropriated by river and harbor act approved June 13, 1902	4,500.00
	6,955.27
June 30, 1902, amount expended during fiscal year	2,242.57
July 1, 1902, balance unexpended	4,712.70
July 1, 1902, outstanding liabilities	24.50
July 1, 1902, balance available	4,688.20
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement, in addition to the balance unexpended July 1, 1902	4,500.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

Obion River, Tennessee.

By act of—	
July 13, 1892	$7,500
August 18, 1894	7,500
June 3, 1896	6,000
March 3, 1899 (for maintenance)	2,500
Total	23,500

Forked Deer River, Tennessee, and its navigable branches.

By act of—	
August 2, 1882, for South Fork	$3,000
July 5, 1884, for South Fork	2,000
August 5, 1886, for South Fork	5,000
August 11, 1888, for South Fork	2,500
August 11, 1888, for North Fork	4,500
August 11, 1888, for main river	2,500

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[a] Consolidated balance.

By act of—

September 19, 1890, for North Fork and main river	$2,500
July 13, 1892, for Forked Deer River (completing improvement)	3,000
Total to complete project	25,000
June 3, 1896, for Forked Deer River (for maintenance)	1,000
June 3, 1896, for North Fork or Middle Fork from Dyersburg to Mississippi River	5,000
March 3, 1899, for Forked Deer River (for maintenance)	2,000
Total	33,000

Obion and Forked Dear rivers, Tennessee.

By act of June 13, 1902 (for maintenance)	$4,500

COMMERCIAL STATISTICS.

Obion and Forked Deer rivers, Tennessee, from January 1 to December 31, 1901.

	Tons.
Logs	7,342
Lumber	2,938
Staves	14,740
Timber	1,254
Spokes	225
Salt	3
Flour	20
Hay	58
Grain	33
General merchandise	104
Total tonnage	26,717
Estimated value	$71,521
Passengers carried	1,100

List of steamboats (stern-wheel) plying upon Obion and Forked Deer rivers, Tennessee.

Name.	Registered dimensions.			Net tonnage.
	Length.	Breadth.	Depth.	
	Feet.	*Feet.*	*Feet.*	
Jacob Heatherington	128	24	4.2	192
Minnehaha	90	18	3	46
A. R. Hall	72	15	11.5	39
L. H. Buhrman	112.6	23.2	4.9	80
Verona	43.2	11	2	6
Sarah	79	25.6	5.5	17
Hock White	60	15	2.5	14
Joy Patton	100	21.3	5.6	63
Gypsey	53	8.5	3.4	14

B B 2.

IMPROVEMENT OF CUMBERLAND RIVER, TENNESSEE AND KENTUCKY, BELOW NASHVILLE, TENNESSEE.

For description of this stream, character of its obstructions, and efforts for its improvement made from 1830 until the adoption of the present project, also for statement of certain examinations and surveys made from 1870 to 1880, see the following reports of the Chief of Engineers: 1871, page 474 et seq.; 1896, page 1905 et seq.; 1899, page 2238 et seq.

During the fiscal year ending June 30, 1902, $420 were expended.

During the past fiscal year no active operations were carried on, owing to lack of funds. The engineer property, buildings, and floating plant were in charge of watchman. At the close of the fiscal year there is a small balance of $455.17 remaining of the river and harbor act of March 3, 1899, which is available for pay of watchman and necessary minor expenses.

The cost of maintenance of the river below Nashville in its present condition is estimated at $5,000 per annum, and such maintenance forms a part of the adopted project under the head of "Snagging below Nashville."

If Congress deems it wise to make improvement by canalization above Carthage, Tenn., estimates show that the upper river improvement will cost four times as much and take four times as long for completion as the lower river improvement, and might be expected to greatly cheapen the cost of transportation to and from the farms near the banks of the upper river; whereas the lower river improvement, though costing only one-fourth as much in money and time, may be expected to greatly cheapen the cost of transportation to and from the farms along its banks, too, and to greatly reduce the cost of innumerable commodities that would then seek this means of going to and from the Ohio Valley. Indeed, it appears too obvious to require further elucidation that earlier and larger returns may be expected from the lower river improvement than from the upper river improvement. Therefore it seems well warrantable that early provision be made for the construction of 6 more locks and accessories below Nashville, and that the 7 locks (1 now built) constituting the lower river system of improvement be made operative at the earliest admissible date.

It seems impossible to urge the course that has just been indicated with too much vehemence, being apparently the only way of securing a return for the expenditures already incurred and that may hereafter be incurred within a reasonable time and for a reasonable additional outlay.

If large boats could be assured an all-year stage of water between Nashville and the Ohio Valley, it is probably not saying too much that a reduction of 30 per cent in most freight charges to and from Nashville, Clarksville, and perhaps other points, would inevitably follow, and I do not hesitate, therefore, to ask for one-half the sum that will be required to carry the lower river scheme of improvement to completion at an early day, and the accompanying money statement has been prepared accordingly.

It is noticed that the instructions for the preparation of the annual report for the fiscal year ending June 30, 1902 (General Orders, No. 2, Office Chief of Engineers, May 15, 1902), state that "commercial statistics are of the greatest importance in connection with a consideration of the value and necessity of new improvements or extension of old ones, and they should be prepared with the utmost care." It is therefore deemed desirable and interesting to make a comparative study of the tables of commercial statistics for the four years of my administration, with a view to arriving at the most important interests to be benefited by the improvement.

A close scrutiny of the tables for the Lower Cumberland River having revealed several rather incongruous and illogical increases and decreases in tonnage and values from year to year, it was therefore proposed to compile revised or corrected tables for the calendar years 1898, 1899, and 1900 and to separate float from steamboat tonnage; also in cases where the items differed 50 per cent or more from year to year the shippers were to be asked for explanations.

However, in attempting to reproduce the data for these years the memoranda in the office upon which the figures were based seemed to be incomplete in some cases, therefore the attempt to issue satisfactory corrected tables was abandoned and it was also a question whether probable tardiness in receiving replies from shippers would not delay the annual report. Nevertheless the revision as above proposed was carried far enough to show several unaccountable discrepancies, in some cases there being apparent over and in some cases apparent under estimations. For example, in 1898 the item of live stock shows 44,000 tons and in 1899 6,200 tons; in 1900, 2,720 tons. Inasmuch as the comparative tonnage of live stock for 1899 and 1900 does not show such a remarkable difference as that of 1898 from these two years, it may be assumed that the item of 1898 is considerably overestimated. Next, taking up the item of grain, we have in 1898 35,427 tons; 1899, 152,936 tons; in 1900, 8,716 tons. In attempting to reproduce the tonnage of grain for 1899 only 31,464 tons could be accounted for, and it is not readily determined from the records whether the former or the latter estimation is correct, as a good deal of information is obtained informally.

Coming to the question of values, it will be seen that the total tonnage for 1898 was 120,232, value $5,711,998.58; in 1899, total tonnage, 263,808, value $4,771,049; and 1900, total tonnage, 407,088, value $5,140,616. Attention is invited to the fact that while the tonnage for 1899 is more than double, and that of 1900 more than treble that of 1898, the values for 1899 and 1900 are less than for 1898. This may be accounted for to some extent by the heavy grade and comparative cheapness of some of the items on the list for 1899 and 1900, showing a remarkable increase in tonnage, such as railroad ties, lumber, sand, gravel, etc. There are other items that might be discussed, but it is deemed sufficient to merely indicate where some of the inconsistencies were to be found, in order that attention might be directed to the value to be placed upon commercial statistics as furnished officers.

It may be proper to state in this connection, that inasmuch as especial stress has lately been placed upon the accurate compilation of these reports, greater care will be exercised in the future to obtain logical results.

The commerce of the Cumberland River below Nashville during the calendar year 1901, as far as could be ascertained, aggregated 255,557 tons, having an estimated value of $3,694,413.

It may, perhaps, be pertinent to state as a matter of information in connection with the commercial statistics of the river that the Ryman Steamboat Line, of Nashville, Tenn., reports that it has built a large elevator and warehouse during the fiscal year 1901 at a cost of $50,000, on the bank of the Cumberland River opposite the city wharf, which will be used in transferring freight between the railroad and boats.

Money statement.

July 1, 1901, balance unexpended		$875.17
Amount appropriated by river and harbor act approved June 13, 1902, as amended June 28, 1902		180,000.00
		180,875.17
June 30, 1902, amount expended during fiscal year		420.00
July 1, 1902, balance unexpended		180,455.17
July 1, 1902, outstanding liabilities		228.05
July 1, 1902, balance available		180,227.12
Amount (estimated) required for completion of existing project		1,534,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$767,250.00	
For maintenance of improvement	5,000.00	
		772,250.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

Improving Cumberland River, Tennessee and Kentucky, general river, 1832 to 1838.

Act of—	
July 17, 1832	$30,000
June 28, 1834	30,000
July 7, 1836	20,000
March 3, 1837	55,000
July 7, 1838	20,000
Total	155,000

Improving Cumberland River below Nashville, Tenn., under old project for open-channel work, from 1871 to 1890.

Act of—	
March 3, 1871	$30,000
June 10, 1872	20,000
March 3, 1873	25,000
March 3, 1875	25,000
June 18, 1878	45,000
March 3, 1879	40,000
June 14, 1880	20,000
March 3, 1881	15,000
August 5, 1882	$15,000
July 5, 1884	7,500
August 5, 1886	12,500
August 11, 1888	10,000
September 19, 1890	40,000
Total	305,000

Under new project for locks and dams, from 1892 to 1902.

Act of—	
July 13, 1892	$40,000.00
August 18, 1894	30,000.00
June 3, 1896	80,000.00
March 3, 1899	100,000.00
Amended act of June 13, 1902	180,000.00
Total	430,000.00
Received on account of sales	161.95
Aggregate	430,161.95

COMMERCIAL STATISTICS.

Cumberland River below Nashville, Tenn., from January 1 to December 31, 1901.

	Tons.		Tons.
Logs	16,213	Iron	280
Lumber	11,868	Peanuts	100
Timber	20,024	Coal	2,050
Railroad ties	146,447	Salt	775
Wood	20	Flour	815
Hoop poles	1,000	Produce	1,200
Heading	713	Hay	3,000
Spokes	8,450	Grain	10,313
Staves	1,200	Hogs	1,500
Shingles	32	Horses	500
Sand	8,274	Mules	300
Lime	151	Cattle	800
Cement	159	General merchandise	12,638
Explosives	1,418		
Crude materials for explosives	1,130	Total tonnage	255,557
Fertilizers	1,000		
Bricks	187	Estimated value	$3,694,428
Tobacco	3,000	Passengers carried	12,000

List of steamboats (stern-wheel) plying on the Cumberland River below Nashville, Tenn., calendar year 1901.

Name.	Registered dimensions.			Net tonnage.
	Length.	Breadth.	Depth.	
	Feet.	*Feet.*	*Feet.*	
Jacob Heatherington	128	24	4.2	192
Fritz	120	26	3.8	153
T. H. Davis	149.4	27.3	5.2	240
J. F. Buckham	88.6	18	2.9	67
G. M. Sively	123.5	24	4.6	98
Key City	80	15	3.1	59
J. M. Bowell	120.6	22.9	4.3	94
Lyda	120	21.4	3.4	92
Dick Clyde	95.8	17.4	3.9	76
Lula E. Warren	122	22.5	3.3	78
L. H. Buhrman	112.6	23.2	4.9	80
Inverness	129	21	4.8	121
Russell Lord	160	30	5	186
R. A. Speed	124	22	4.4	140
Pavonia	120	26	4	132
Ten Broeck	130	26	3.9	148
Sycamore	103.6	20.3	3	69
Lora	70	12	2.5	44
Thos. Parker	100	18.1	4.5	57
A. L. Goldberg	129	20	3	58
Victor	120	26	4	100
Penguin	80	16.6	3.4	60
J. B. Richardson	165	29	4	191
H. W. Buttorff	160	30	4.1	160
Kuttawa [a]	58	10	2.5	12

[a] Gasoline.

ABOVE NASHVILLE, TENN.

The distance from Nashville to Cumberland Ford (Pineville) is about 497 miles, and from Nashville to head of Smith Shoals, mouth of Rockcastle River, is 357 miles. The head of navigation is at Burnside, Ky., 325 miles above Nashville, Tenn., with a fall of 223 feet.

A general description of the Upper Cumberland, showing the character of its obstructions and of its navigability for steamboats, is given in Report of the Chief of Engineers, 1896, page 1909. A report as to worthiness of this improvement was submitted to the Chief of Engineers with letter dated June 25, 1902.

For detailed description of Cumberland River above Nashville see Reports of the Chief of Engineers, 1871, pages 468–485; 1872, pages 462–472.

The amount expended under the existing project during the fiscal year ending June 30, 1902, is $36,750.80, the disbursements being classified as follows:

General improvement:		
Lock No. 1	$60.00	
Lock No. 2	290.33	
Lock No. 3	328.65	
Lock No. 4	303.25	
General expenses	1,268.37	
		$2,250.60
Locks Nos. 5, 6, and 7:		
Lock No. 5	12,115.65	
U. S. S. *Cumberland*	189.80	
		12,305.45
Locks and Dams Nos. 1, 5, 6, and 7: Lock No. 1		22,114.75
Locks and Dams Nos. 21 and 22: Amount reserved for expenses, Office Chief of Engineers		80.00
		36,750.80

There is a balance of $3,023.46 of the appropriation of August 18, 1894, now available for general improvement, which is recommended to be made available for the lower-river improvement except what may be needed for contingencies.

During the fiscal year operations have been carried on at Lock No. 1 under contract for construction of lock approaches and abutment protection with James E. Sloan & Co., and also at Lock No. 5, by the hired-labor system.

The present condition of the work at the locks for which the several sites have been selected, approved, and acquired by the United States in whole or in part, is as follows:

Lock No. 1 (2.5 miles below Nashville).—Masonry of lock and abutment of dam completed. The river and harbor act of March 3, 1899, provides for the Cumberland River above Nashville, Tenn., as follows: * * * "One hundred thousand dollars, of which amount so much as may be available, besides the amount required for essential maintenance, may be applied toward the completion of unfinished Locks and Dams One, Five, Six, and Seven, or either of them."

The approved project for the expenditure of this sum contemplated the completion of excavation of the approaches to Lock 1, also the grading of banks and placing necessary bank protection, the work at Lock 1 being the most economical and advantageous to the Government by reason of the desirability that the excavation be completed before the dam at Harpeth shoals is built.

The work of excavating approaches, etc., contemplated by the above project was completed by the contractors on December 27, 1901. (See pp. 2898 and 2904, Report of the Chief of Engineers, 1900.) This contract expired by limitation December 31, 1901, but under its provisions thirty days were allowed for the removal of waste material, etc., from the site and grounds. High water interfered with these operations, therefore the time limit was waived for a reasonable period to allow the cleaning up to be done, so as to leave the whole in good order. At the close of the fiscal year this work had not been done, pending which final payment is withheld from contractors, James E. Sloan & Co.

During the fiscal year the work done under this contract was as follows:

At lock site:		
Earth excavation above lock	cubic yards..	28
Earth excavation below lock	do....	125.17
Rock excavation above lock	do....	664.50
Rock excavation below lock	do....	1,424.83
Concrete	do....	1,498.10
Paving	do....	234.10
Stone filling	do....	118.28
Terra-cotta pipe	linear feet..	108
Bolt holes	do....	80.90
Wooden sills	feet B. M..	1,248
Removing old cofferdam	linear feet..	357
At abutment site:		
Stone filling	cubic yards..	135.32
Paving	do....	.90
Riprap	do....	375.74

The above work cost $20,962.08.

There is a balance of $19,682.47 remaining of the appropriation of March 3, 1899, of which $8,214.72 is pledged for retained percentage on above contract, and the balance, $11,467.75, is now available for work at Lock 5 and maintenance, according to the approved project for expenditure of appropriation of above act. This balance is recommended to be made available for the lower river improvement, except what may be needed for contingencies.

Locks Nos. 2, 3, and 4 (9 miles, 26 miles, and 44.75 miles above Nashville, respectively).—Masonry of locks complete; abutments of dams not yet built. No work in progress other than watching engineer property stored at locks.

Lock No. 5 (72 miles above Nashville).—Work was carried on during the entire year by the United States by hired labor, and the purchase of supplies was made under the existing regulations. The following work was done:

Roof of steamer *Cumberland* repaired; riprap quarried, 5,560 cubic yards; riprap delivered on bank back of lock wall, 939.32 cubic yards, and bank protected above and below pier derricks, 565.72 cubic yards. This bank protection consisted of riprap, hand placed, 266.19 cubic yards; riprap used on bank under water, 203.35 cubic yards; heavy stone for footing course under water, 31.68 cubic yards, and riprap used in paving gully, 64.50 cubic yards.

During the fiscal year ending June 30, 1901, $12,305.45 were expended on this lock and contingencies. There is a balance of $21,361.45 remaining of the sundry civil act of July 1, 1898, which is available for work at Lock 5, repair of plant and maintenance of the same. I recommend that the above balance be made available below Nashville, except what may be needed for contingencies.

During the fiscal year $450.17 were collected from the sureties on the bond of J. H. Connor on account of his failure to carry out his contract with the United States dated January 15, 1895, for furnishing stone for part construction of Lock 5.

Lock No. 6 (89.6 miles above Nashville).—Masonry of lock walls and abutment of dam completed.

Lock No. 7 (106.6 miles above Nashville).—Masonry of lock walls and abutment of dam completed.

Lock No. 8 (125.25 miles above Nashville).—Sites for the lock and abutment have been approved. The abutment site has been conveyed to the United States. The lock site has not yet been acquired.

Locks Nos. 9 to 20.—No surveys have been made to determine and select the sites for these locks.

Lock No. 21 (in Kentucky, 296.25 miles above Nashville and 28.75 miles below Burnside, Ky.).—By act of June 3, 1896, $20,000 were made specifically applicable to Locks Nos. 21 and 22, and the sites for these locks and abutments of dams have been acquired by the United States.

There is a balance of $16,875 applicable to Locks 21 and 22, which is recommended to be made available below Nashville, except what may be needed for contingencies.

During the fiscal year the sum of $80 was reserved by the Chief of Engineers for office expenses from the above appropriation.

Lock No. 22 (320.25 miles above Nashville and 4.75 miles below Burnside, Ky.).—The sites for lock and abutment have been acquired by the United States.

Smith shoals section—Locks Nos. 1 to 6.—The project provided originally for seven locks and dams between Burnside and mouth of Rockcastle River, Kentucky, 29.7 miles, but the number was reduced to six locks by authority of August 12, 1895. The reasons for the modification are published in Report of Chief of Engineers, 1896, page 1915. The sites for these locks and abutments of dams have been approved and authority granted to obtain the lands by voluntary purchase, if practicable; otherwise, by condemnation. No disbursements were made on account of Smith shoals during the fiscal year.

The allotments for this section are as follows:

By act of September 19, 1890	$50,000.00
Less amount made available for expenditure under the approved project for the general improvement of the Cumberland River above Nashville, Tenn., by authority of Secretary of War, September 1, 1896	30,000.00
Balance	20,000.00
Amount allotted "above Burnside," act of July 13, 1892	5,000.00
Amount allotted "above Burnside," act of August 18, 1894	5,000.00
Total available	30,000.00
Amount expended to June 30, 1901	20,252.94
Balance available July 1, 1901	9,747.06

The above balance is recommended to be made available for the improvement below Nashville, except what may be needed for contingencies.

With the completion of the operations now in progress at Locks 1 and 5, the work remaining to be done in order that the seven locks (1 to 7, inclusive) may be made operative is estimated to cost $813,740.15, as per detailed statement given in Report of Chief of Engineers for 1899, pages 2245–2246. It would be well to increase this estimate 15 per cent, with prices varying as they do at present; but these operations could well be deferred until the improvement below Nashville is completed, and recommendation is made accordingly.

Channel work, or maintaining improved channel.—No active operations were carried on during the fiscal year under this head, owing to lack of available funds.

The annual expenditure for these open-channel operations is estimated at $5,000.

A detailed statement of the general method of carrying on the work was published in the report of Assistant Engineer J. S. Walker. (See Report of Chief of Engineers, 1898, p. 1877.)

It is expected to send a snagging party to work over the river as soon as practicable after funds are available.

Coming now to the consideration of the question of commercial statistics for the Upper Cumberland River gathered during the term of my incumbency, I was also constrained to seek some explanation for certain apparent inconsistencies noticed for this section of the river in making horizontal comparisons from year to year, the same controlling reasons existing for making this comparative study as are given in detail in the report for the Lower Cumberland River hereinbefore (see Appendix B B 2), to which attention is invited.

In scanning the tables of tonnage for 1898, 1899, and 1900, it appears that the tonnage for 1898 and 1899, with the corresponding values, advance in the proper proportions, but when the total tonnage and values for 1899 and 1900 are scrutinized we are confronted by a most remarkable set of figures, viz, a decrease in tonnage from 1899 to 1900 of some 5,500 tons, but an increase in total value of nearly $4,000,000, or about 87 per cent. It is a matter of utmost difficulty, or rather a practical impossibility, to determine now whether there was an underestimation of value for 1899 or an overestimation for 1900, owing to the amount and character of correspondence that would have to be undertaken with the various concerns to determine this fact and the small likelihood of receiving satisfactory explanations at this time. By separating as nearly as possible float from steamboat tonnage the incongruity seems more pronounced, viz, 198,683 tons in 1899 with an approximate valuation of $3,912,414, as against 168,798 tons in 1900 with an approximate valuation of $7,643,221. It will be noticed that there is a decrease in tonnage for 1900 of 29,840 tons and an increase in valuation of $3,730,807, or about 95 per cent. Again, parties in sending reports give the item of general merchandise a value of from about $70 to $300 per ton, and small quantities have been reported as high as $500 per ton. It must be confessed that serious doubts are entertained by me even as to the approximate correctness of these units of valuation. In 1899 an item of live stock was reported to this office as follows: "Seventeen thousand five hundred head, valued at $20,640." This would give each head a valuation of about $1.18, a result the accuracy of which is quite doubtful. Without intending to reflect in the least degree on the good faith of the parties furnishing the office with tonnage, I am constrained to remark that until some method is devised to have parties pay especial heed to the preparation of commerce reports, serious doubts will always exist as to their correctness. The act of Congress approved February 21, 1891, being an act to "facilitate the collection of commercial statistics," provides:

> That owners, agents, masters, and clerks of vessels arriving at or departing from localities where works of river and harbor improvement are carried on shall furnish, on application of the persons in local charge of the works, a comprehensive statement of vessels, passengers, freight, and tonnage.

The law as it stands does not seem to reach the rafting on the river, considerable of which is done on this section, there having been floated in 1900 some 107,802 tons. While efforts are always made to get this floatage, yet it is doubtful if complete returns are rendered, and it is therefore suggested that if the law also specifically applied to business of this character, the tonnage of logs would doubtless be considerably increased.

In view of these considerations, it may perhaps not be out of place to suggest that, inasmuch as questions concerning appropriations for river improvements are based largely on tonnage reports furnished Congress, it necessarily follows that Congress is entitled to have placed before it the most accurate information obtainable concerning statistics of this character. In furtherance of this end, if legislation could be secured requiring transportation companies and other proper parties to furnish under oath the information required by Congress, it is confidently asserted that the element of doubt would be to a great degree removed, and the rendition of more accurate information would doubtless be the result.

In compliance with section 7, river and harbor act of 1899, the determination of worthiness involved too much elaboration for incorporation in this report; therefore the study on the subject was submitted to the Chief of Engineers in a separate report. The conclusions reached, however, were as follows: The section of river below Nashville on which two locks are built is twice as worthy of improvement as the section between Nashville and Carthage on which six locks are built, and the section between Nashville and Carthage is ten times as worthy of improvement as the section above Carthage on which no work has been done.

However, it is not claimed as far as learned that the outlay for canalization above Carthage is warrantable except mainly for the purpose of reaching coal fields alleged to be there. These fields should be vast to warrant an expenditure of $6,000,000 in transportation facilities. It is respectfully submitted, therefore, as a fair business proposition that at least the extent, depth, and quality of the coal said to be there should be accurately determined by borings and openings before incurring the expenditure.

My recommendation therefore is that the section below Nashville be pushed to completion before everything else; that the section between Nashville and Carthage be completed next; but I am obliged to regard the section above Carthage as unworthy of improvement except through a fostering care of the Government by maintenance of existing open-channel works.

Money statement.

July 1, 1901, balance unexpended	$106,990.46
Damages recovered from failing contractor's surety	450.17
Amount appropriated by river and harbor act approved June 13, 1902, as amended June 28, 1902	200,000.00
	307,440.63
June 30, 1902, amount expended during fiscal year	36,750.80
July 1, 1902, balance unexpended	270,689.83
July 1, 1902, outstanding liabilities	9,339.39
July 1, 1902, balance available	261,350.44
July 1, 1902, amount covered by uncompleted contracts	8,214.72
Amount (estimated) required for completion of existing project	6,605,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, for maintenance of improvement in addition to the balance unexpended July 1, 1902	5,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

Improving Cumberland River above Nashville, Tenn., under original projects for open-channel work, from 1876 to 1884.

Geographical division.	Act of— Aug. 14, 1876.	June 18, 1878.	Mar. 3, 1879.	June 14, 1880.
1. Nashville to Kentucky line	$15,000	$20,000	$18,000	$15,000
2. Kentucky line to Smith shoals	10,000	8,000	6,000	10,000
3. Smith shoals	25,000	30,000	15,000	20,000
4. Smith shoals to Falls of Cumberland	2,000	2,000		
Total	52,000	60,000	39,000	45,000

Geographical division.	Act of— Mar. 3, 1881.	Aug. 2, 1882.	July 5, 1884.	Total.
1. Nashville to Kentucky line	$15,000			$83,000
2. Kentucky line to Smith shoals	15,000			49,000
3. Smith shoals	10,000	$15,000		115,000
4. Smith shoals to Falls of Cumberland				4,000
5. Above mouth of Jellico, Kentucky	10,000	5,000		15,000
6. Nashville to Smith shoals		30,000		30,000
7. Nashville to head of Smith shoals			$50,000	50,000
Total	50,000	50,000	50,000	346,000

Improving Cumberland River above Nashville, Tenn., under the present project for a system of locks and dams from Nashville, Tenn., to head of Smith shoals, mouth of Rockcastle River, Kentucky.

Act of—	
August 5, 1886	$75,000.00
August 11, 1888	200,000.00
September 19, 1890	250,000.00
July 13, 1892	250,000.00
August 18, 1894	200,000.00
June 3, 1896	20,000.00
June 4, 1897 (sundry civil act)	350,000.00
July 1, 1898 (sundry civil act)	250,000.00

Act of—	
March 3, 1899	$100,000.00
Amended act of June 13, 1902	200,000.00
Total	1,895,000.00
Amount recovered from failing contractor	450.17
Aggregate	1,895,450.17

CONTRACT IN FORCE, IMPROVING CUMBERLAND RIVER ABOVE NASHVILLE, TENN.

No. 1.

Name and address of contractor: Jas. E. Sloan & Co., Nashville, Tenn.

Purpose: Construction of lock approaches and abutment protection.

Date entered: September 12, 1899.

Date of approval: September 29, 1899.

Date of beginning work: October 9, 1899.

Date of expiration: December 31, 1901. (Original date of expiration, December 31, 1899, extended to December 31, 1900, and again extended to December 31, 1901. Time limit waived for a reasonable period to allow cleaning up of lock site and grounds.)

COMMERCIAL STATISTICS.

Cumberland River above Nashville, Tenn., from January 1 to December 31, 1901.

	Tons.		Tons.
Logs	126,420	Salt	3,355
Cedar posts and poles	4,721	Flour	1,805
Lumber	32,567	Produce	4,293
Railroad ties	5,918	Hay	1,692
Wood	1,652	Grain	7,393
Hoop poles	2,470	Oil-well supplies and machinery	43
Spokes	450	Hogs	3,757
Staves	12,864	Horses	542
Handles	3,656	Mules	300
Shingles	96	Cattle	2,215
Sand	24,487	Stone	960
Lime	162	General merchandise	17,752
Cement	158		
Fertilizers	1,500	Total tonnage	257,211
Bricks	378		
Tobacco	3,490		
Peanuts	15	Estimated value	$7,064,775
Coal	2,100	Passengers carried	18,773

List of steamboats (stern-wheel) plying on the Cumberland River above Nashville, Tenn., and in Kentucky, calendar year 1901.

Name.	Registered dimensions.			Net tonnage.
	Length.	Breadth.	Depth.	
	Feet.	*Feet.*	*Feet.*	
A. L. Goldberg	129	20	3	58
Henry Harley	160	29	3.2	162
John W. Thomas	160	26.5	4.2	158
T. L. Herbert	117	24	3.6	80
Lora	70	12	2.5	44
Raymond	102.6	22	3	45
G. M. Sively	123.5	24	4.6	98
Thos. Parker	100	18.1	4.5	57
Jas. N. White	147	27	3	77
Burnside	136	21	4.6	92
Burkesville	116.5	17.1	3.8	59
R. Dunbar	160	29.4	6.4	158
Bob Dudley	160	29	3.8	159
Albany [a]				
Anderson [b]	50	7.5	1.4	12.8
Eadsville [b]	44	8	1.4	2
E. Campbell [b]	53	9	1.6	8

[a] Dimensions not reported.

[b] Gasoline.

B B 3.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

Wreck of steamer W. K. Phillips in Dover Island chute, Lower Cumberland River.—This wreck consists of the bottom and a portion of the side planking; all the machinery, boilers, and heavy iron have been removed. It lies with bow upstream and parallel to the bank, which at this point is a bluff. Reported as a dangerous wreck by one J. G. Williams, Cumberland City. Tenn. Report made to Chief of Engineers by the engineer officer in charge, September 26, 1900;

removal authorized October 6, 1900, and allotment made under the provisions of the river and harbor act of March 3, 1899.

An expenditure of $12.50 was made from the allotment for the necessary expenses of Assistant Engineer J. S. Walker, who was directed to make the examination. As a measure of economy to the Government, it was thought best to delay the removal of the wreck until such time as the United States snag boat made a trip over the river in regular course, it being thought disadvantageous to the Government to fit up a snagging party especially for this purpose, and the delay not being deemed detrimental to the interests of navigation. However, as no funds for snagging became available in 1901, the snag boat was not sent out. Funds being now appropriated for channel work, the wreck will be removed as soon as the snag boat reaches it in due course.

APPENDIX CC.

IMPROVEMENT OF TENNESSEE RIVER AND ITS TRIBUTARIES.

REPORT OF MAJ. JOHN G. D. KNIGHT, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Tennessee River.
2. Operating and care of Muscle Shoals Canal, Tennessee River.
3. French Broad River and Little Pigeon River, Tennessee.
4. Clinch River, Tennessee and Virginia.
5. Hiwassee River, Tennessee.
6. Holston River, Virginia and Tennessee.

SURVEY.

7. Tennessee River from Scott Point to Lock A, Muscle Shoals Canal.

ENGINEER OFFICE, UNITED STATES ARMY,
Chattanooga, Tenn., July 18, 1902.

GENERAL: I have the honor to transmit herewith * * * my annual report for the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1902, * * * .

Very respectfully,

JOHN G. D. KNIGHT,
Major, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

C C 1.

IMPROVEMENT OF TENNESSEE RIVER.

* * * * * * *

The Muscle Shoals Canal, consisting of two sections whose combined length is 17 miles, and terminating 263 miles above the mouth of the Tennessee River, affords the only practicable route for boat communication between the upper and lower sections of the river.

Besides others, two cities, each of about 33,000 inhabitants, are situated on the river: Chattanooga, Tenn., 464 miles up the river, and Knoxville, Tenn., 647 miles. Extensive mineral resources exist in the counties adjacent to the upper third of the river, but most of these are not directly on the river banks. With the exception of Sheffield and Florence, Ala., all centers of industry on the river are situated above the Muscle Shoals Canal. Through traffic by boats of deep draft is out of the question. Traffic by large tows of boats and barges of light draft finds obstructions at high stages of the river in the 17 miles of canal, with limiting depth of water of 5 feet and locks 60 by 300 feet, and at three bridges with draw spans of from 119 to 125 feet. Considering the dimensions, including draft, of tows navigating the Ohio River, it is at once manifest that, even during high stages of the Tennessee River, competition on the two rivers for the delivery of bulk freight at points below their junction is not practicable.

At low water, besides the obstacles above specified, there exists the great one to be found in the uncertainty of the occurrence of low-water stages. Records for twenty-two years show that April is the only month during that period in which one year or another the monthly mean stage at Chattanooga has not fallen below 5 feet. For four months, August to November, inclusive, this stage has been below 4 feet; and for nearly eleven years this stage during May, June, and December has been below 5 feet. The fluctuations at Chattanooga during the past year are shown on the accompanying chart, and are of especial interest in connection with the question of the utilization of water power developed by any fixed dam constructed across the river in the vicinity of Chattanooga.

The conclusion seems inevitable that through traffic, even by small tows of boats and barges, having a maximum loaded draft of 4 feet, would be made possible the year round only by a system of locks and dams from the Colbert Shoals Canal to the headwaters of the river, a distance of 393 miles, excluding the Muscle Shoals Canal. The total fall of the river over this section is 317 feet. To overcome this by the system mentioned would cost not less than $10,000,000, and very likely more.

What measure of improvement is demanded?

The situations below and above Riverton, Ala., are different. Below it the transportation needs of the farmer and lumberman are now readily met by boats running the entire year; above Riverton other interests rule—those of the manufacturer and the merchant. Of the two, the manufacturer is the better favored by railroad facilities; for, as a rule, large concerns have side tracks by which material is delivered or removed direct without additional cost of transfer by team. Not so the merchant, and from him especially comes the demand that the river may be so improved as to regulate railroad charges.

The steamer placed on the river by the merchants of Chattanooga in February, 1901, because of dissatisfaction with railroad freight rates, resumed its trips between that city and Paducah in November, 1901, and later extended them to Cairo. This boat was the only one running the entire distance between the mouth of the river and Chattanooga, 464 miles.

From the freight reports rendered when passing Lock 6, of the Muscle Shoals Canal, this boat carried through the canal 1,907 tons on its 8 up trips, and 763 tons on its 8 down trips, a total of 2,670 tons during a period of 3.5 months up to the interruption of traffic by a break in the canal at the end of March, 1902. Had this break not occurred the total tonnage moved by this boat during the season would have been about 5,000.

The following tables show why it was put in commission:

Freight rates by boat and rail per 100 pounds.

To Chattanooga from—	By—	Class.					
		First.	Second.	Third.	Fourth.	Fifth.	Sixth.
Cairo, Ill., or Paducah, Ky	Rail	$0.76	$0.65	$0.57	$0.47	$0.40	$0.30
	Boat	.30	.25	.21	.18	.15	.12
New York and Eastern seaport towns, but via Paducah, Ky	Rail	1.14	.98	.86	.73	.60	.49
	Rail and boat	1.00	.90	.74	.56	.47	.39
Saving by last route		.14	.08	.12	.17	.13	.10

Railroad freight rates per 100 pounds from New York direct.

To—	Class.					
	First.	Second.	Third.	Fourth.	Fifth.	Sixth.
Nashville, Tenn	$0.91	$0.78	$0.60	$0.42	$0.36	$0.31
Memphis, Tenn	1.00	.85	.65	.45	.38	.32

From these tables it is evident that were railroad rates from New York to Chattanooga reduced to those ruling from New York to either Nashville or Memphis, freight from the East to Chattanooga would no longer be taken to that place by boat from Paducah.

There would, however, remain the existing advantage of boat rates over rail rates on freight between Chattanooga and Paducah.

Measures were revived again this year toward placing a second boat in the Chattanooga-Paducah line, but, as before, failed of completion.

Allowing for all probable increase in this through traffic for many years to come, the expenditure of several millions of dollars to enable the traffic to be continued during the entire year is not justified.

When the Colbert Shoals Canal is completed, and by small additional work navigation the year round is opened up from Paducah to Sheffield, it may easily be determined whether the iron furnaces at the latter place will avail themselves of the river for the movement of pig iron. If they do not, it is certain that furnaces located above the Muscle Shoals Canal will not.

For the present and some years to come, the improvement called for is that of dredging, removal of snags and reefs, construction of low dams, either partially or wholly submerged, and possibly, where the channel is formed along a bank of the river, bank protection.

The amount so far allotted and appropriated for the Tennessee River and the canals thereon, including amount for operating the latter, is $6,304,672.88. Of this sum, $720,146.85 was allotted for operating and care and repair of Muscle Shoals Canal from the time it was opened to navigation in November, 1890, to June 30, 1902.

Further details as to the river follow under subheadings covering the different river sections.

1. ABOVE CHATTANOOGA (188 MILES).

* * * * * * *

The improvement resulting from this work has not always been quite permanent. It is the tendency of such work to form a bar at the lower end of the chute where the water expands and the velocity of the current diminishes, and finally, as the bar increases, to transfer the difficulties downstream.

The funds on hand at the beginning of the fiscal year were not sufficient to permit active operations, and were expended in the care of plant. The fleet belonging to the Tennessee River above Chattanooga, and its tributaries, consist of 1 steamboat, 1 dipper dredge, 1 naphtha launch, 2 steam derrick boats, 3 quarter boats, and 4 stone barges.

Money statement.

July 1, 1901, balance unexpended		$51.13
Amount appropriated by river and harbor act approved June 13, 1902		50,000.00
		50,051.13
June 30, 1902, amount expended during fiscal year		21.11
July 1, 1902, balance unexpended		50,030.02
July 1, 1902, outstanding liabilities		30.02
July 1, 1902, balance available		50,000.00
Amount (estimated) required for completion of existing project		505,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$20,000.00	
For maintenance of improvement	5,000.00	
		25,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Nineteen appropriations have been made by Congress for this work, aggregating the sum of $441,000.

Act of—		Act of—	
April 10, 1869	$35,000	July 5, 1884	$3,000
June 10, 1872	25,000	August 5, 1886	7,500
March 3, 1873	25,000	August 11, 1888	15,000
June 23, 1874	25,000	September 19, 1890	30,000
March 3, 1875	40,000	July 13, 1892	25,000
August 14, 1876	15,000	August 18, 1894	50,000
June 18, 1878	15,000	June 3, 1896	15,000
March 3, 1879	11,500	March 3, 1899	30,000
June 14, 1880	10,000	June 13, 1902	50,000
March 3, 1881	7,000		
August 2, 1882	7,000	Total	441,000

2. CHATTANOOGA, TENN., TO RIVERTON, ALA. (237.3 MILES).

CHATTANOOGA, TENN., TO DECATUR, ALA. (159.7 MILES).

* * * * * * *

The mountain section is deemed safely navigable for craft drawing 3 feet when the Chattanooga gauge reads 3 feet or more. The following table shows that this section was practically closed to such craft during but one month, November, 1901:

Chattanooga gauge readings.

Month.	Number of days.		
	Less than 3 feet.	3 feet or more.	4 feet or more.
1901.			
July	5	26	16
August	6	25	24
September	0	30	30
October	6	25	13
November	30	0	0
December	6	25	20
1902.			
January	0	31	31
February	0	28	28
March	0	31	31
April	0	30	30
May	0	31	31
June	0	30	9

* * * * * * *.

During November, 1901, the Chattanooga gauge varied from 2.1 to 2.6 feet; but light-draft boats were run during the month between Chattanooga and Decatur without experiencing any practicable trouble. Tumbling Shoals, 10 miles below Chattanooga, was reported as the worst place, on account of, not insufficient water, but eddies.

DECATUR, ALA., TO FLORENCE, ALA. (47.8 MILES).

* * * * * * *

The Big Muscle Shoals and Elk River canals constructed in this section have by no means made its navigation possible at all stages of the river. Critical points exist not more than 6 miles above the Elk River Division, between the two divisions, and about 4 miles below the Muscle Shoals Division.

A mile and a half above the Florence railroad bridge, Sweetwater Creek enters the river from the right bank. After heavy rains its waters bring down and deposit in the river channel large masses of gravel. In consequence, annual dredging in this locality will generally be needed.

The dry dock, sawmill, machine shop, etc., located at Lock 6 of the the Muscle Shoals Canal, were used for the repair of United States dredge, snag barge, and dump scows.

FLORENCE, ALA., TO FOOT OF BEE TREE SHOALS (29.8 MILES)

Bee Tree and Colbert shoals, beginning about 22 miles below Florence, form the principal obstruction to navigation during low water.

These shoals, which may be considered as forming one continuous obstacle, are 8 miles in length, with a total fall of 25 feet at low water, at which stage the available depth is about 1.5 feet.

Four islands divide the river through the shoals longitudinally, and the work heretofore carried on for the improvement of navigation consisted in building riprap dams which, in connection with the islands, confined the water to the chute along the north bank. Increased depth was obtained by channel excavation. This method does not give results adequate to the present needs of commerce.

The navigation of these shoals by boats drawing 3 feet is deemed practicable when the Riverton gauge reads 5 feet or more.

The following table shows that they were practically closed to such boats during the months of July, October, and November, 1901, and May and June, 1902:

Riverton gauge readings.

Month.	Number of days.		
	Less than 5 feet.	5 feet or more.	6 feet or more.
1901.			
July	29	2	1
August	10	21	21
September	9	21	19
October	31	0	0
November	30	0	0
December	14	17	17
1902.			
January	2	29	26
February	0	28	26
March	0	31	31
April	2	28	24
May	25	6	5
June	30	0	0

* * * * * * *

The work at the lock during the past year consisted in caring for plant and keeping the structures already built in good condition. The slopes of the embankments were repaired whenever damaged by rains or floods; grass and weeds were kept cut and new grass set where needed.

Money statement.

July 1, 1901, balance unexpended		$19,075.28
Amount appropriated by river and harbor act approved June 13, 1902		200,000.00
		219,075.28
June 30, 1902, amount expended during fiscal year		7,530.81
July 1, 1902, balance unexpended		211,544.47
July 1, 1902, outstanding liabilities		6,906.37
July 1, 1902, balance available		204,638.10
Amount (estimated) required for completion of existing project		4,927,939.81
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$400,000.00	
For maintenance of improvement	6,000.00	
		406,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

March 2, 1827	$200.00	August 2, 1882	$250,000.00
August 30, 1852	50,000.00	August 7, 1882	3,970.13
June 9, 1860	1,350.00	July 5, 1884	350,000.00
June 12, 1860	1,406.94	August 5, 1886	262,500.00
July 25, 1868	85,000.00	August 11, 1888	250,000.00
April 10, 1869	5,095.00	September 19, 1890	450,000.00
July 11, 1870	80,000.00	March 17, 1891 (transfer settlement	3.91
June 10, 1872	50,000.00	July 13, 1892	475,000.00
March 3, 1873	100,000.00	August 18, 1894[a]	275,000.00
June 23, 1874	100,000.00	June 3, 1896	50,000.00
March 3, 1875	360,000.00	March 3, 1899	135,000.00
August 14, 1876	255,000.00	June 13, 1902	200,000.00
June 18, 1878	300,000.00		
March 3, 1879	210,000.00		
June 14, 1880	300,000.00	Total	4,849,526.03
March 3, 1881	250,000.00		

[a] Erroneously reported last year as $310,000.

3. TENNESSEE RIVER BELOW RIVERTON, ALA. (226 MILES).

* * * * * * *

The dredge *Kentucky*, which has been built for service in this section of the river, was in use from the beginning of the fiscal year until December 6, 1901, when work was discontinued in consequence of exhaustion of funds. During this period material (gravel) was removed from the channel, as follows:

	Cubic yards.		Cubic yards.
Diamond Island	19,500	Newburg Landing	450
Wolf Island	37,800	Big Chain bar	53,245
Double Island	3,700	Head of Tennessee Island	52,300
Rockport bar	16,100		
Head of Sandy Island	2,600	Total	185,695

About 20,000 cubic yards of this gravel was cemented and difficult to remove.

The cost of this dredging was 9.7 cents per cubic yard for gravel; 21.4 cents per cubic yard for cemented gravel, and 56.5 cents per cubic yard for rock.

Additional details, and approximate amount of dredging remaining to be done, are given in the reports of February 7 and March 4, 1902, of Mr. J. E. Hall, which are transmitted herewith.

LIVINGSTON POINT, KENTUCKY.

* * * * * * *

Money statement.

July 1, 1901, balance unexpended		$17,748.02
Amount appropriated by river and harbor act approved July 13, 1902		19,000.00
		36,748.02
June 30, 1902, amount expended during fiscal year		17,748.02
July 1, 1901, balance unexpended		19,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$15,000.00	
For maintenance of improvement	4,000.00	
		19,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1897.		

APPROPRIATIONS.

[For Tennessee River below Riverton, Ala.]

September 19, 1890	$25,000	June 13, 1902	$19,000
July 13, 1892	25,000		
August 18, 1894 [a]	125,000	Total	294,000
March 3, 1899	100,000		

[a] Erroneously reported last year at $90,000.

COMMERCIAL STATISTICS.

Tennessee River above Chattanooga, Tenn. (188 miles).

Articles.	Year ending Dec. 31, 1901.		Articles.	Year ending Dec. 31, 1901.	
	Tons.	Estimated value.		Tons.	Estimated value.
Brick	128	$558	Lumber	7,556	$94,450
Coal	6,450	12,900	Marble	50,325	503,250
Cotton seed	34	600	Produce	1,251	130,727
Fertilizer	313	6,260	Railroad ties	300	600
Flour	1,720	77,378	Sand	81,000	56,700
General merchandise	6,478	705,148	Shingles	6	1,755
Grain	11,336	303,092	Stone	3,570	8,490
Hay	5,422	83,368	Tan bark	520	3,200
Iron ore	50,000	62,500			
Live stock	229	15,988	Total	294,607	2,604,931
Logs and wood	67,969	537,967			

Floated down in rafts .... tons.. 67,089
Number of passengers transported (1901) 6,988

Details of the traffic for 1901 are shown in the following table:

	Miles.	Passengers.	Tons.
Timber and lumber rafted:			
From headwaters of Clinch, Powell, and Holston rivers to Chattanooga	183	....	52,338
Out of Clinch River to Chattanooga	103.5	....	8,000
From Knoxville to Loudon	56.5	....	2,734
Out of Holston River to Knoxville	4.5	....	2,879
Miscellaneous	....	....	1,168
By boat:			
Lenoir City and Chattanooga	137	800	23,626
Loudon and Chattanooga	127	1,783	47,484
Kingston to Dayton	64	....	50,000
Out of French Broad River to below Knoxville	6.5	1,500	74,999
Out of French Broad River to Knoxville	5.5	1,600	11,751
Walker Island to Chattanooga	5	....	18,000
Miscellaneous	....	1,305	1,628
Totals	....	6,988	294,607

Of the 17 steamboats reported in the last annual report as plying on the Tennessee River above Chattanooga, Tenn., the *City of Charleston*, *Dixie*, *Key City*, *Ocoee No. 2*, *Onega*, and *Telephone* were not in this service during the year, and two being small tugs in local towing service, are dropped; and the number of barges was reduced from 72 to 48.

No additional boats were put on.

The total number of craft operating in this section of the river during the year ending December 31, 1901, was 9 steamboats, of a total of 660 tons burden, net, and 48 barges, of a total capacity of 3,239 tons.

Of these steamboats, 3 are also reported as plying on the French Broad River, 4 on the Clinch, and 1, also, on both.

List of boats and barges navigating Tennessee River above Chattanooga, Tenn.

Names of steamboats.	Tonnage.	Barges.		Between what points.	Miles.
		Number.	Tonnage.		
Charles H. Bacon	22	4	80	Kingston and Louisville, Tenn	56
Clinch	24	2	150	Lenoir City, Kingston, and Chattanooga	137
Grady	137	8	1,400	Kingston and Dayton	64
Isabella King	89	6	600	Louisville and Riverdale	44½
Oliver King	42	6	150	....do	44½
Flora Swann	57	11	308	Knoxville and Leadvale	74
Joe Wheeler	192	1	100	Loudon, Kingston, and Chattanooga	127
W. T. Gallaher	27	2	125	Knoxville and Chattanooga	183
Bill Tate	70	2	150	Knoxville and Kingston Knoxville and Leadvale	79 74
Barges	....	2	36	Seven Island Shoals and Knoxville	18
Do	....	3	120	Chattanooga, Tenn., and Walkers Island	5
Barge	....	1	20	Marble quarries and Knoxville	6½
Total	660	48	3,239		

Tennessee River, between Chattanooga, Tenn., and Florence, Ala.

Articles.	Year ending Dec. 31, 1901.		Articles.	Year ending Dec. 31, 1901.	
	Tons.	Estimated value.		Tons.	Estimated value.
Brick and tile	1,484	$7,079	Logs and wood	57,861	$274,202
Coal	1,574	3,148	Live stock	1,260	88,200
Cotton	5,260	946,755	Lumber	11,341	141,760
Cotton seed	1,942	35,300	Produce	1,177	82,795
Fertilizer	2,235	44,700	Sand	10,575	7,403
Flour	5,825	262,125	Staves	149	5,323
General merchandise	23,856	2,609,105	Stone	808	4,040
Grain	3,107	60,169	Tan bark	49	392
Hay	425	7,650			
Iron, pig	232	4,176	Total	129,160	4,584,322

Number of passengers transported (1901), 18,611.

Of the traffic for 1901, 25,389 tons were moved by raft; 10,600 by flatboat; and 7,921 passengers and 38,175 tons of freight by railroad transfer boats between Hobbs Island and Guntersville, a distance of 22 miles. Of the remaining 55,000 tons, 3,557 were carried by the through boat running between Chattanooga and Paducah.

Details of the traffic for 1901 are shown in the following table:

	Miles.	Passengers.	Tons.
Chattanooga and Paducah	464	874	3,557
Chattanooga and Lambs Ferry	183	1,782	18,515
Chattanooga and Decatur	160		504
Chattanooga and South Pittsburg	46		8,640
Kellys Ferry and Lock 1	168	6,978	28,477
Bridgeport and Decatur	110		9,600
Guntersville and Florence	102	35	6,800
Guntersville and Suck	94		1,428
Guntersville and Decatur	54		4,657
Guntersville and Hobbs Island	22	7,921	38,175
Decatur and Hamburg	103	500	840
Decatur and Florence	48	17	471
Decatur and Lambs Ferry	24		80
Lambs Ferry and Riverton	55	500	3,692
Lambs Ferry and Lock A	5		670
Elk River and Florence	29		300
Miscellaneous		4	2,754
Total		18,611	129,160

Of the 22 steamboats reported in the last annual report as plying on the Tennessee River between Chattanooga, Tenn., and Florence, Ala., 9, having a total of 806 tons, were not in this service during the year, and the number of barges was reduced from 91 to 44. One additional boat was put on, the *Gasconade*, of 74 tons burden, but was withdrawn in May, 1901, for the Hiwassee River trade.

The total number of craft operating in this section of the river during the year ending December 31, 1901, was 14 steamboats, of a total of 1,256 tons burden, net, and 44 barges, of a total capacity of 7,845 tons, as shown on list below.

The steamboats, *Avalon*, *Bessie Smith*, and *Lucile Borden* are also reported as plying on the Tennessee River between Florence, Ala., and Paducah, Ky.

List of boats and barges navigating the Tennessee River between Chattanooga, Tenn., and Florence, Ala., during the year 1901.

Names.	Tonnage.	Barges.		Between what points.	Miles.
		Number.	Tonnage.		
Avalon	305	....	....	Chattanooga and Paducah	464
B. F. Young	160	18	4,050	Chattanooga and Lock 1	187
Decatur No. 1	48	6	1,350		
N. B. Forrest	134	2	200	Chattanooga and Lambs Ferry	183.4
Sam Davis	93	1	100		
City of Charleston	84	2	500	Shellmound and Guntersville	67.3
Gladys	30	4	400	Guntersville and Florence	101.3
Hattie McDaniels[a]	67	2	320	Guntersville and Hobbs Island	21.4
Huntsville[a]	89	1	100		
Gasconade	74	2	150	Decatur and Florence	48.1
Luke Pryor, Jr	68	....	....		
Bessie Smith	50	1	70	Decatur, Ala., and Hamburg, Tenn	103
Mattie	9	....	....	Ferry at Decatur, Ala	.3
Lucile Borden	45	2	140	Lambs Ferry and Riverton	54.6
Barges	....	3	465	Bridgeport, Ala., and Raccoon Creek	38
				Bridgeport, Ala., and Island Creek	4
				Chattanooga and South Pittsburg	46
Total	1,266	44	7,845		

[a] Operated by railroad company.

Tennessee River, between Florence, Ala., and Paducah, Ky.

Articles.	Year ending Dec. 31, 1901.		Articles.	Year ending Dec. 31, 1901.	
	Tons.	Estimated value.		Tons.	Estimated value.
Coal	35,160	$70,320	Lumber	13,403	$167,538
Cotton	1,738	312,795	Peanuts	5,759	691,080
Cottonseed	239	4,344	Railroad ties	483,202	966,403
Fertilizer	8,970	179,400	Staves, etc	12,677	115,697
Flour	3,530	158,850	Stone	106	1,060
General merchandise	22,724	2,409,082	Tan bark	904	8,136
Grain	9,765	585,213	Tobacco	86	20,640
Hoop poles	6,683	53,464	Wood	4,552	6,828
Iron, pig	570	10,260			
Live stock	2,856	199,920	Total	658,102	6,322,450
Logs	45,178	361,420			

Of this, 39,981 tons were moved in rafts.
Number of passengers transported (1901), 20,773.

The following table gives the details for the year 1901:

	Miles.	Passengers.	Tons.
Chattanooga to Paducah	464	874	3,557
Decatur, Ala., and Hamburg, Tenn	103	500	840
Lambs Ferry and Riverton, Ala	55	500	3,692
Florence and Paducah	237	....	295,737
Riverton and Paducah	226	16,875	207,753
Savannah and Paducah	189	....	20,095
Cerro Gordo and Paducah	177	1,714	10,900
Wills Point and Paducah	176	....	2,671
Clifton and Paducah	158	....	33,211
Ferryville and Paducah	184	....	5,673
Bobs Landing and Paducah	159	....	1,799
Altona and Paducah	14	300	39,035
Miscellaneous	....	10	33,039
Total	....	20,773	658,102

Of the 49 steamboats reported in last annual report as plying on this section of the river, 19, of a total of 3,829 tons, were not in this service during the year, but the number of barges was increased from 223 to 298.

Six additional boats were put on as follows:

Names of steamboats.	Length.	Width.	Depth.	Net tonnage.	Height of pilot house.	Height of smoke-stacks.	Number of barges.	Capacity. of barges.
	Feet.	*Feet.*	*Feet.*		*Feet.*	*Feet.*		*Tons.*
Charleston	122	25	4	94	28	38		
I. N. Hook	109.9	19.4	3	55			8	1,600
Inverness	129	21	4.8	121	29	39	2	450
I. O. K	60	13	2	14			1	40
Ten Broeck	130	26	3.9	148	30	48	7	2,350
Wilford	85	18.8	3	47			5	1,000

The total number of craft operating in this section of the river during the year ending December 31, 1901, was 37 steamboats, of a total of 5,344 tons burden, net, and 298 barges, of a total capacity of 102,205 tons, as shown on list below. Three steamboats, the *Avalon*, *Bessie Smith*, and *Lucile Borden*, a total of 400 tons burden, and 3 barges, total capacity 210 tons, are also reported as plying on the Tennessee River between Chattanooga and Florence, Ala.

List of boats and barges navigating the Tennessee River between Florence, Ala., and Paducah, Ky., during the year 1901.

Names.	Tonnage.	Barges.		Between what points.	Miles.
		Number.	Tonnage.		
Avalon	305			Chattanooga and Paducah	464
Bessie Smith	50	1	70	Decatur, Ala., and Hamburg, Tenn	103
Lucile Borden	45	2	140	Lambs Ferry and Riverton	54.6
Inverness	121	2	450	Florence and Paducah	256.9
Ten Broeck	148	7	2,350		
J. M. Bowelle	94	8	1,600		
Lyda	92	9	3,250		
Pavonia	132	15	14,625		
R. A. Speed	140	8	1,800		
Russell Lord	186	20	19,500		
Clyde	335			Waterloo and Paducah	226.5
City of Sheffield	329				
City of Paducah	318				
City of Clifton	265				
City of Memphis	322				
Fritts	153	10	5,000		
Jacob Heatherington	192	15	7,500		
Josie	233	3	2,400		
Penguin	60	10	3,250		
Tennessee	248				
Victor	138	8	2,600		
Will J. Cummins	177				
J. M. Richtman	132	8	800	Riverton, Ala., and Paducah	226.5
T. H. Davis	240	15	9,000		
Dick Clyde	76	5	4,050	North Carolina Landing and Paducah.	205.5
I. N. Hook	55	8	1,600	Savannah, Tenn., and Paducah	189.5
Wilford	47	5	1,000		
Woodruff	40	5	1,700		
Thomas Parker	57	5	2,105	Shiloh and Paducah	198
Charleston	94			Cerro Gordo, Tenn., and Paducah	177.8
L. H. Buhrman	80	16	8,000	Clifton and Paducah	158
Lula E. Warren	78	6	1,000		
Emma Cooper	79	3	1,400	Bobs Landing and Paducah	150.5
Wabash	182	2	900	Cedar Creek Landing and Paducah	141.3
I. O. K	14	1	40	Danville, Tenn., and Paducah, Ky	78.3
J. B. A	51	50	3,000	Altona, Ky., and Paducah	13.9
Mary N	36	50	3,000		
Barge		1	75	Gilbertsville and Paducah	21.9
Total	5,344	298	102,205		

None operated by railroad companies.

REPORTS OF MR. J. E. HALL, INSPECTOR OF DREDGING.

Engineer Office, United States Army,
Chattanooga, Tenn., February 7, 1902.

Major: I have the honor to submit the following report of operations of United States dredging plant on the Tennessee River, below Riverton, Ala., during the season of 1901:

The plant consisted of the dredge *Kentucky*, a 4-yard dipper dredge, built by the

Bucyrus Company in 1899–1900; 3 dump scows, each having a capacity of 100 yards; 1 fuel barge, 1 towing barge for handling dredge, 1 quarter boat for office purposes and subsistence stores, and the U. S. steamer *Lookout*, serving as dredge tender and towboat.

After the close of the season's work in 1900 the dredge was docked and repaired at Paducah, Ky., and the *Lookout*, with the remainder of the plant, was sent to Muscle Shoals Canal for repairs.

The plan of operations for the season of 1901 was to begin at Paducah and take the obstructions in their sequence up the river, but if prevented by backwater from the Ohio, to move the plant to the upper end of the work and proceed downstream, removing only the most serious obstructions on the way down, in order to reach Big Chain Bar and Tennessee Island bar during low-water season, which were then considered the most serious impediments to navigation below Big Bend shoals.

The *Lookout*, with that part of the plant repaired at Muscle Shoals Canal, reached Paducah on June 22. The dredge and boat were then provided with a double crew and a supply of coal and subsistence stores, and on June 25 the *Lookout* left Paducah for the upper end of the work with the entire plant in tow, a large rise in the Ohio having compelled the adoption of the alternative part of the plan. The plant reached Diamond Island, the first obstruction below Big Bend shoals, on July 1. The dredge began the season's work here with a double crew, working sixteen hours per day, until November 15, when the force was reduced to a single crew, and the work continued until December 6, when orders were received to discontinue work and proceed at once with plant to Muscle Shoals Canal, where it could be taken care of through the winter at a minimum expense.

The following places were improved during the season of 1901, viz, Diamond Island Bar, Wolf Island chute, Double Island Bar, Rockport Bar (or Duck River Island Bar), Big Chain Bar, Tennessee Island Bar, Big Chain, Blood River Island, and Sandy Island. The last three improvements were made after the force was reduced.

DIAMOND ISLAND (30 MILES BELOW RIVERTON).

This was the first serious obstruction below Big Bend shoals, and consisted of a shallow gravel bar just above head of island and opposite Government light on left shore, and the wrecks of steamer *Rapidan* and ammunition barge, the location of which, as well as that of the improved channel, are shown on accompanying sketch[a] (No. 1). The dredge began work here on July 2 and completed the improvement on July 12. The stage of water at the time of work ranged between 10 and 6 feet above extreme low water.

The material dredged was a coarse gravel underlaid in some places with a stratum of blue clay. Five cuts were made through this bar, opening a channel 175 feet wide and 5 feet deep at extreme low water.

Excavation made July 2 to 12.

Coarse gravel	cubic yards	19,500
Wrecks removed, steamer *Rapidan* and ammunition barge	number	2

WOLF ISLAND CHUTE (CRUMP'S LANDING), 33 MILES BELOW RIVERTON.

The river at this place is divided by Wolf Island into two chutes of almost equal size. The right chute is obstructed by a large gravel bar, rendering the entrance thereto very tortuous and exceedingly difficult for boats with tows. For this reason the left chute, which has its entrance straight with the current, is used as the channel and was the one improved.

This was effected by the removal of the following obstructions: Gravel bar above Crumps Landing, gravel bar one-half mile below landing, jutting rocky points at landing, and several other rocky points of similar nature, all of which are shown on accompanying sketch[a] (No. 2). The first two obstructions mentioned were of loose gravel and easily removed. The rocky spurs were more difficult, as they required blasting. Their removal not only served to widen the channel, but greatly improved the current by diminishing the effect of the eddies formed by the projecting points.

The gauge during this improvement ranged between 7.5 and 2.7 feet.

Excavation made July 13 to August 8.

Soft material	cubic yards	28,500
Cemented gravel	do	8,000
Cemented gravel requiring blasting	do	1,300
Total		37,800

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[a] Not printed.

DOUBLE ISLAND (78 MILES BELOW RIVERTON).

The channel here is near the right shore and was obstructed near the lower end of islands by a gravel bar, which was formed and held in place by several ledges of cemented gravel rock.

The plant reached this place on August 10. While here six days were lost owing to high water, and the improvement was completed on the 16th just as a second rise had reached the dredging limit. The location of improvement is shown on accompanying sketch [a] (No. 3).

Excavation made August 9 to 16.

Loose gravel	cubic yards..	2,200
Cemented gravel	do...	1,500
Total		3,700

ROCKPORT BAR (OR DUCK RIVER ISLAND BAR), 120 MILES BELOW RIVERTON.

The plant reached this place on August 17, but owing to high water remained inactive until September 4.

This place had been improved on two previous occasions, in 1898 and 1900, the channel in each instance being made parallel to the island shore, and opening into the deep eddy at foot of island. As these channels filled up in a single season, while the old channel, which crossed from the island to Government light on right shore, seemed to show but little change since the 1895 survey, the new channel was made in this direction in order to avoid the eddy. Six cuts were made through the bar of an average length of 600 feet, opening a channel 210 feet wide and 5 feet deep at extreme low water.

At the lower end of bar a large rack heap was encounted, formed of logs and whole trees. Its removal may prevent the bar from forming again. (Sketch No. 4.[a])

Excavation made August 17 to September 11.

Loose gravel	cubic yards..	16,100
Snags removed	number..	13

BIG CHAIN BAR (212 MILES BELOW RIVERTON).

The channel here was obstructed by a long flat bar extending from a point 1,000 feet above Government light on left shore to a point about 1,200 feet below same. The upper end of bar to within 400 feet of a point opposite the light was underlaid with reefs of a hard blue limestone, which was very difficult to remove even after being blasted. The remainder of bar was composed of cemented and loose gravel.

The plant reached this place on September 12, and began work, which was interrupted by a rise on the 18th, and could not be resumed until the 28th. The improvement was finished on October 24. Five cuts were made through the bar 2,000 feet in length, making a channel 175 feet wide and 5 feet deep at extreme low water, with the exception of one ledge, which crosses the channel 500 feet above the light, over which there is only 4.5 feet at extreme low water. Considerable time was spent in trying to reduce this ledge to grade, but the surface blasting had but little effect on it. In order to get the shortest distance through the obstruction, it was necessary to make an angle in the channel opposite the light. Its location is shown on accompanying sketch [a] (No. 5).

Excavation made September 12 to October 23.

Gravel	cubic yards..	47,300
Cemented gravel	do...	3,000
Rock	do...	2,700
Total		53,000

TENNESSEE ISLAND (224 MILES BELOW RIVERTON).

The channel here was obstructed by two bars, one at head of island and the second about 800 feet below the first. They are evidently of recent formation, as the survey of 1896 shows a channel of ample depth here. They were composed of fine gravel and sand, different from any other bars encountered on the Tennessee River, and were doubtless deposited by the Ohio. They were held in place by snags, logs, and whole trees, which were so interlapped as to make their removal very difficult.

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[a] Not printed.

The dredge began work here on October 24, and completed the improvement November 16. Five cuts were made through each bar, opening a channel 175 feet wide and 5 feet deep at extreme low water. (Sketch No. 6 [a]).

Excavation made October 24 to November 16.

Sand and loose gravel	cubic yards..	52,300
Snags removed	number..	20

BIG CHAIN ROCK (211 MILES BELOW RIVERTON).

The plant, after obtaining a supply of coal, left Paducah on November 18, on the way up the river.

In pursuance of your instructions, the force was reduced to a single crew, in view of the fact that the work for the remainder of the season would likely be jobs of short duration, and much time would necessarily be lost in getting from one point to another, making surveys, and preparing for work at each place.

The plant reached Big Chain Rock on November 19. This obstruction is a chain of rock, which crosses the river here at an angle of about 45° with the banks. The channel passes through a gap near the middle of river, which is 250 feet wide, but owing to the direction of the crossing ledge, its available width was much less. The location of ledge and old and new channels is shown on accompanying sketch (No. 5).

The obstruction removed is known to pilots as the Middle Rock, and was a dangerous obstruction, three steamboats having been lost by striking against this rock. It is of a chert and limestone formation, and was very hard to drill, owing to its hardness and also to gravel pockets, which were frequently encountered. The dredge on the 26th completed the removal of the rock to a depth of 5 feet at extreme low water. Its removal serves at once to straighten the channel and add 100 feet to its width.

Excavation made November 17 to 27.

Rock	cubic yards..	245

BLOOD RIVER ISLAND (175 MILES BELOW RIVERTON).

The obstruction at this place was located about 500 feet above Government light on right shore and consisted of several lumps of cemented gravel, which so narrowed the channel that during low water period it was necessary for towboats with large tows to divide same before passing. Two cuts were made here on November 28, each about 250 feet in length, almost doubling the width of channel.

Excavation made November 28.

Cemented gravel	cubic yards..	450

SANDY ISLAND (156 MILES BELOW RIVERTON).

The obstruction here was similar in character to that removed at Blood River Island, but extended over a much larger area. It consisted of a series of cemented gravel lumps scattered along at intervals of from 30 to 50 feet apart, the water between them being from 10 to 15 feet in depth, while over the lumps themselves the depth was only about 3 feet.

Three cuts were made here of an average length of 700 feet, removing 2,600 cubic yards of cemented gravel. This gives a channel 200 feet wide and 5 feet deep at extreme low water. The improvement was completed on December 6, on which date orders were received to take the plant to Lock 6, where it could be cared for during the winter and repaired. The plant reached Muscle Shoals Canal December 24.

Excavation made December 2 to 6.

Cemented gravel	cubic yards..	2,600

The following is a tabulated statement of dredging done on the Tennessee River below Riverton, Ala., during the season of 1901. The dredge from the beginning of the season until November 15 was operated with a double crew, each crew working eight hours per day, thus making each calendar day two eight-hour days for that time. After November 16 it continued operations with a single crew.

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[a] Not printed.

Time at work:	Days.
Dredging gravel and soft material	116
Dredging cemented gravel	26
Dredging rock	12
Removing snags	4½
Removing wrecks	2
Total	160½

Time lost:	
Sundays	46
Holidays	3
Traveling	46½
High water	52
Rain and fogs	6
Accidents	12
Total	165½

Time in commission, 326 days of 8 hours each.

Nature of work.		Average per day.	Total during season.
Gravel and soft material excavated	cubic yards	1,430	165,900
Cemented gravel excavated	do	648	16,850
Rock excavated	do	245.4	2,945
Total amount dredged during season	do		185,695
Snags removed	number		33
Wrecks removed	do		2

DREDGE IN COMMISSION.

Cost of equipment and repairs.

Per day in commission	$3.27
Per day of work	6.61
For the season	1,061.49

Cost of fuel.

Per day in commission	$5.01
Per day of work	10.14
For the season	1,627.98

Salaries and subsistence.

Per day in commission	$31.90
Per day of work	64.59
For the season	10,367.00

Total cost.

Per day in commission	$40.18
Per day of work	81.34
For the season	13,056.47

Cost of annual repairs, 1901.

Salaries during annual repairs	$5,020.37
Shop bills, material, etc	4,177.34
Total cost	9,197.71

Cost of work, including all expenditures for 1901.

Dredging gravel and soft material	$16,084.17
Dredging cemented gravel	3,604.91
Dredging rock	1,663.80
Removing snags	624.00
Removing wrecks	277.30
Total	22,254.18

Cost per unit.

Per cubic yard gravel	$0.097
Per cubic yard cemented gravel	.214
Per cubic yard rock	.565
Per cubic yard excavated	.12
Per day in commission	68.26
Per day of work	138.66

The unit cost was very much increased by the prevalence of floods during the dredging season, on account of which fifty-two days were lost, or about one-fourth of the entire time.

The only dredging by contract done on this end of the river was in 1897, when the United States chartered the Huse & Loomis plant. The unit cost of material handled by this plant was 29.3 cents per cubic yard, chiefly loose gravel. The contract price for removing the limestone ledges at Ross Towhead was $3.75 per cubic yard.

Respectfully submitted.

J. E. Hall, *Inspector of Dredging.*

Maj. John G. D. Knight,
Corps of Engineers.

Location and description of work.

Name of place.	Miles below Riverton.	Date, 1901.	Days of work.	Quantities removed.					
				Snags.	Wrecks.	Gravel.	Cemented gravel.	Rock.	Per day of work.
				No.	*No.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*
Diamond Island	30	July 2-11	15			19,500			1,300
Do	30	July 12	2		2				
Wolf Island chute	33	July 13-Aug. 8	21			28,500			1,360
Do	34	do	13.5				9,300		689
Double Island	78	Aug. 9-16	2			2,200			1,100
Do	78	do	3.5				1,500		429
Rockport bar	120	Aug. 17-Sept. 11	11.5			16,100			1,400
Do	120	do	2.5	13					
Big Chain bar	212	Sept. 12-Oct. 23.	31.5			47,300			1,501
Do	212	do	4				3,000		750
Do	212	do	9					2,700	300
Tennessee Island	224	Oct. 24-Nov. 16.	35			52,300			1,494
Do	224	do	2	20					
Big Chain Rock	211	Nov. 17-27	3					245	81
Blood River Island	175	Nov. 29	1				450		450
Big Sandy Island	156	Dec. 6	4				2,600		650
Total			160.5	33	2	165,900	16,850	2,945	

Name of place.	Miles below Riverton.	Cost.						Total, 1901.
		Per cubic yard.	Snags removed.	Wrecks removed.	Excavated—			
					Gravel.	Cemented gravel.	Rock.	
Diamond Island	30	$0.106			$2,079.80			$2,079.80
Do	30			$277.30				277.30
Wolf Island chute	33	.102			2,911.75			2,911.75
Do	34	.201				$1,871.78		1,871.78
Double Island	78	.126			277.30			277.30
Do	78	.323				485.28		485.28
Rockport bar	120	.099			1,594.50			1,594.50
Do	120		$346.70					346.70
Big Chain bar	212	.092			4,367.77			4,367.77
Do	212	.185				554.60		554.60
Do	212	.462					$1,247.85	1,247.85
Tennessee Island	224	.093			4,853.05			4,853.05
Do	224		277.30					277.30
Big Chain Rock	211	1.712					415.95	415.95
Blood River Island	175	.308				138.65		138.65
Big Sandy Island	156	.213				554.60		554.60
Total			624.00	277.30	16,084.17	3,604.91	1,663.80	22,254.18

ENGINEER OFFICE, UNITED STATES ARMY,
Chattanooga, Tenn., March 4, 1902.

MAJOR: In relation to the operation of the United States dredging plant on the lower division of the Tennessee River during the coming season, I have the honor to submit the following observations:

The original project for improving this section was to excavate a channel through all obstructing reefs, bars, etc., 150 feet wide, with a 5-foot depth at extreme low water. On this basis an estimate was made from the general maps, giving the number of existing obstructions and approximately the amounts to be removed at each in order to obtain the projected improvement.

Since this estimate was prepared dredging has been carried on during three seasons, and a number of the most serious obstructions have been improved. The following table gives the estimate mentioned and the amounts dredged during the three seasons since the estimate was prepared:

Name of locality.	Distance below Riverton.	Minimum depth at extreme low water.	Amount estimated February 10, 1898.	Amount of work since done.		
				1899.	1900.	1901.
	Miles.	*Feet.*	*Cubic yds.*	*Cubic yds.*	*Cubic yds.*	*Cubic yds.*
Riverton Landing	0		36,728G			
Riverton bar	0	2	22,222G			
Waterloo Landing	0		8,055G			
Eastport Landing	1.5		7,963G			
Bear Creek shoals	2	2.3	28,242G			
Indian Creek	6	4.5	1,000G			
Head State Line Island	9	4.8	1,000G			
Winns Landing	12		2,000G			
Duncans Landing	16		16,824G			
Big Bend shoals	20	2.3	24,913R			
Do	22		43,341G			
Hamburg Landing	24		6,139G			
Diamond Island	30	2.9	8,027G			19,500
Wolf Island	33	2.7	38,352G			37,800
Swallow Bluff Island	56	4	2,000R			
Eagles Nest Island	62	4	4,008G			
Beech Creek Island	72	4.5	34,948G		64,800	
Buffalo shoals	76		2,000R			
Double Island	78		3,882G			3,700
Armstrong tow-head	83		4,695G			
Cedar Creek Bar	85		7,497G			
Webbs Landing	89		30,517G			
Beech River	91		3,055G			
Parsons Landing	99		2,000R			
Densons Island	101		2,078G			
Duck River	116		3,000			
Rockport bar	120		13,321	13,162	31,900G	16,100
Duck River sucks	121		6,131R		7,570R	
Do	122				16,500G	
Bird Song Creek	123		2,000G			
Johnsonville landing	130		42,479G		19,000	
Reynoldsburg Island	134		8,843G		12,850	
Green Bottom bar	137		17,918G	1,020	24,550	
Turkey Creek Island	141		4,000R		400	
White Oak Island	144		7,918G	3,410		
Danville bar	149		4,778G			
Hurricane Island	150		4,000G			
Leatherwood shoals	153		8,800G	5,995		
Head Sandy Island	157		20,442G	3,550	10,300	2,600
Mouth Sandy River	160		4,000G			
Panther Creek Island	167		19,947G	10,200		
McCullock's bar	170		9,300G			
Blood River Island	175		2,000G			
Newburg landing	178		29,142G			450
Highland bar	183		27,461G		26,800	
Pentecost Island	184		16,066			
Reynolds bar	188		21,686G			
Grubb's tow-head	195		11,160G		10,000	
Head 27 Mile Island	199		11,214	11,007		
Big Chain bar	211		16,716		13,100	53,245
Head Tennessee Island	224					52,300
Total			653,819	48,344	237,822	185,695

It is evident from the foregoing that 471,860 cubic yards of material have been removed during the three seasons' work of 1899, 1900, and 1901. Much of this, however, was due to maintaining a channel through bars that are constantly forming, notably Duck River bar (or Rockport bar), which has been dredged each season, and the quantity removed in every instance equals or exceeds the original estimate. Also the bar at the head of Tennessee Island, which has formed entirely since the survey was made, from which maps the estimate was prepared. The dredging was all done below Big Bend shoals, as it was thought advisable to get the lower portion of the river in good navigable condition before attempting the improvement of this very formidable obstruction.

At the close of the season's work of 1901, which completed the removal of the most serious obstructions on the lower end, the plant was towed to Lock 6, Muscle Shoals Canal, where, after being repaired, it will be in readiness to begin work on the upper end. * * *

Respectfully submitted.

J. E. HALL, *Inspector of Dredging.*

Maj. JOHN G. D. KNIGHT, *Corps of Engineers.*

C C 2.

OPERATING AND CARE OF MUSCLE SHOALS CANAL, TENNESSEE RIVER.

* * * * * * *

Details and dimensions of locks, aqueduct, and drift sluice are given at page 2445, Report of the Chief of Engineers, 1901.

* * * * * * *

During the last year the operation of the drop gates at Lock 9 was much improved by substituting a steel frame, resting upon stone base blocks, for the old timber frame that held the manipulating gearing.

The gates at Locks A and B were cleaned by the use of a sand blast. The Parker gate, used for a drift sluice above Lock A, which had become entirely worn out, was rebuilt.

Repairs to the dam between Miltons Bluff and Browns Island, for which a special allotment of $4,500 had been made, were completed. This work resulted in an increase in the depth of the channel immediately above the dam of approximately 1 foot. Twice during the year large accumulations of drift had to be removed from above Lock A.

Steel pins were substituted for the set screws which originally fastened the valves to the shafts, as follows: One valve at Lock 6, two at Lock 3, one at Lock 5, and two at Lock 2. This change was made wherever a set screw had sheared off, as they were found not to be heavy enough to stand the strain that falls upon them in opening and closing the valves.

The canal trunk was dredged the full width of the canal and down to solid rock from the eastern entrance to Lock 1, and two cuts were made between Lock 1 and Second Creek. About 50,000 cubic yards of mud and gravel were taken from these sections.

In the embankment 16 leaks occurred during the year, but were stopped without serious damage. Several leaks also appeared in the bed of the canal, one of which, in the pool between Locks 2 and 3, required 300 cubic yards of gravel to fill. This effected a saving in the time of filling the pool, as well as in water for operating purposes below.

The sawmill, dry dock, machine shop, and carpenter shop, which have been located at the canal, partly because it was the largest and most important work on the river and partly because of the water power which existed there, have been of great value, not only in making the necessary repairs upon the canal itself, but also for repairing the fleet employed upon the whole river.

The telephone line connecting each lockmaster's house with headquarters at Lock 6, and from there to the central office at Florence, had become unsatisfactory in its working, owing to parts of the instruments being old and worn. These will be replaced by new parts of the most modern type.

* * * * * * *

In all cases where the work of repair and construction of plant has been done at Muscle Shoals Canal for other sections of the river the cost of this work has been carefully ascertained and charged to the proper appropriations.

The total amount expended for operating and care of the Muscle Shoals Canal during the fiscal year ending June 30, 1902, was $61,529.19.

On the night of March 28 the heaviest rainfall recorded in this section occurred. At Riverton, Ala., the rainfall in twenty-four hours was 7.15 inches. All the water courses were flooded and many county bridges were carried away. Shoal Creek, over which the canal aqueduct is built, rose 10 feet higher than ever known before. The river being low, the water of the creek, containing logs and all kinds of débris, came with terrific force against the side of the aqueduct. Nine bays were broken off through the angles that connected the sides and bottom; the side was torn apart in bay lengths and cast over into the aqueduct; the masonry of nine piers and one abutment was dislodged for from three to six courses down, and much other damage done. Breaks were made in the canal embankment, timber frames under the bridge at Bluewater were washed away, and some floating plant was stranded.

A detailed account of the damage and repairs made appears in Mr. Winn's report, attached hereto and previously referred to.

A special allotment of $30,000 was made for the repair of the canal, and an emergency contract was entered into with Walsh & Weidner for the repair of the iron part of the aqueduct. The completion of this work was delayed by angle irons and plates, ordered in Pittsburg, Pa., being 28 days en route. Most of the work of repair has been done by hired labor.

Repairs were sufficiently advanced by June 4 to permit the resumption of navigation through the canal. The expenses of these repairs to the end of the fiscal year were $17,049.84, and the repairs are still in progress.

Abstract of allotments.

November 28, 1890	$40,000.00
July 1, 1891	31,792.04
July 1, 1892	45,232.90
July 1, 1893	60,975.19
July 1, 1894	63,772.63
July 1, 1895	64,793.11
July 1, 1896	62,707.46
July 1, 1897	67,979.55
July 1, 1898	62,868.17
July 1, 1899	59,239.20
July 1, 1900	$63,000.00
July 20, 1900, to cover deficiency	355.95
November 2, 1900, to repair dam above Lock A	4,500.00
July 1, 1901	62,930.65
April 12, 1902, to repair storm damage	30,000.00
Total	720,146.85

Estimate of funds needed from appropriation for operating and care of canals and other works of navigation (indefinite), to be applied to current expenses in operating the Muscle Shoals Canal from July 1, 1902, to June 30, 1903.

Amount required for fiscal year ending June 30, 1903	$62,000.00
Balance remaining from allotment of preceding year	1,470.81
Additional allotment needed for fiscal year ending June 30, 1903	60,529.19

Detailed expenses for operating and care of Muscle Shoals Canal during the fiscal year ending June 30, 1902.

Month.	Office and administration.			Operating and care.				Grand total.
	Salaries.	Supplies.	Total.	Labor.	Subsistence.	Supplies.	Total.	
1901.								
July	$300.00	....	$300.00	$4,018.93	$499.62	$281.69	$4,800.24	$5,100.24
August	289.16	$2.10	291.26	4,027.23	641.50	1,005.85	5,674.58	5,965.84
September	275.00	....	275.00	4,296.42	395.08	277.94	4,969.44	5,244.44
October	275.00	....	275.00	4,782.53	1,194.10	686.98	6,663.61	6,938.61
November	300.00	....	300.00	4,399.78	612.66	597.48	5,609.92	5,909.92
December	300.00	12.10	312.10	4,141.08	819.85	1,364.61	6,325.54	6,637.64
1902.								
January	300.00	....	300.00	3,992.62	449.83	1,166.60	5,609.05	5,909.05
February	300.00	....	300.00	3,014.53	511.44	113.53	3,639.50	3,939.50
March	300.00	3.31	303.31	2,728.68	400.97	631.36	3,761.01	4,064.32
April	300.00	....	300.00	2,984.60	592.80	118.31	3,695.71	3,995.71
May	300.00	....	300.00	2,910.37	306.47	35.78	3,282.62	3,582.62
June	300.00	....	300.00	3,312.66	458.79	169.85	3,941.30	4,241.30
Total	3,539.16	17.51	3,556.67	44,639.43	6,883.11	6,449.98	57,972.52	61,529.19

The average cost of subsistence per man per month was $8.30.
The average cost of feeding live stock per head per month was $8.12.

Money statement.

July 1, 1901, balance unexpended	$5,441.92
Allotments for fiscal year ending June 30, 1902	92,930.65
	98,372.57
June 30, 1902, amount expended during fiscal year	76.201.22
July 1, 1902, balance unexpended	22,171.35
July 1, 1902, outstanding liabilities	7,750.38
July 1, 1902, balance available	14,420.97

The balance available is composed of two items:

1. Balance of allotment for fiscal year ending June 30, 1902	1,470.81
2. Balance of special allotment of April 12, 1902, for repair of storm damage	12,950.16

COMMERCIAL STATISTICS.

Statement of traffic through the Muscle Shoals Canal during the calendar year ending December 31, 1901, compared with traffic during years ending December 31, 1898; 1899, and 1900.

Articles.	Year ending December 31—				Estimated value, 1901.
	1898.	1899.	1900.	1901.	
Steamers ..... number..	169	218	409	295	....
Barges ..... do....	289	323	419	233	....
Rafts ..... do....	8	2	7	6	....
Miscellaneous craft ..... do....	15	12	12	18	....
Tonnage	31,824	46,546	68,679	73,702	....

Statement of traffic through the Muscle Shoals Canal, etc.—Continued.

Articles	Year ending December 31—				Estimated value, 1901.
	1898.	1899.	1900.	1901.	
Coal .... tons..	917	306	212	25	$50
Cotton .... do....	1,046	959	847	304	54,720
Cotton seed .... do....	1,074	1,710	804	945	17,010
Flour .... do....	69	....	5	20	900
General merchandise .... do....	685	1,070	2,594	4,093	421,348
Grain .... do....	234	604	268	391	9,771
Live stock .... do....	74	16	36	5	350
Logs .... do....	230	2,865	....	60	480
Lumber .... do....	5,935	4,222	7,049	2,616	32,700
Staves .... do....	....	....	1,000	440	24,750
Spoke timber .... do....	....	....	....	2,706	30,075
Wood .... do....	....	2,567	2,066	320	480
Total	10,264	14,319	14,881	11,625	592,634
Passengers .... number..	4,685	5,466	7,962	8,901	....

Number of lockages (1901), 3,221.
The above is exclusive of supplies carried by Government steamers.

REPORT OF MR. W. S. WINN, ASSISTANT ENGINEER.

United States Muscle Shoals Canal,
Kingman, Ala., June 30, 1902.

Major: I have the honor to make the following report of work done, in connection with the operation and care of the United States Muscle Shoals Canal, for the fiscal year ending June 30, 1902:

Acting under your orders, I assumed local charge of the canal August 17, 1901, relieving Mr. Sidney B. Williamson, assistant engineer, who was transferred to the Newport, R. I., district.

For a general description of the canal, the property of the United States thereat, and its principal features, your attention is respectfully invited to Assistant Engineer Williamson's annual report for 1901, printed in the Chief of Engineer's Report for that year (p. 2444, et seq.).

There are, however, several corrections that should be made as to depth on miter sills. The zeros of the gauges at the different locks were placed at the same elevation as the tops of the cushion sticks on top of the miter sills. I have checked these and find that they agree to within one-tenth of a foot. At Lock 1 the water, October 11, 1895, went to 3.1 on the gauge. There was therefore only 3.1 feet depth on the sill at that time. While 1895 is the lowest I have any record of for Lock 1, it was not the lowest water recorded for other points on the river. It is likely, then, that there will be times when there will be less than 3 feet on the Lock 1 sill. At Lock 9 the minimum depth on the lower sill should have been given as 3.6, instead of 5, as given in the report above referred to. The canal was designed to have a minimum depth of 5 feet on the sills of all the locks, and I thought it well to call attention to the structures that have fallen short of the original intention, thinking that when the reaches of the river immediately above and below the canal come up for improvement, corrections of these shortcomings might be made parts of the projects for the new improvements. In a report to you, under date of October 18, 1901, upon a plan for improving Little Muscle Shoals, provision was made for backing the water upon Lock 9 sill to a minimum depth of 5 feet. When the reach between Locks 1 and B, embracing Nances reef and Gilchrist chute, is taken up, it is likely that increasing depth on Lock 1 sill may be made a part of the project at a less expense and in a more satisfactory manner than if each were undertaken separately. At present there is no apparent necessity for increasing depth on either sill, as there is already greater depth there than over the shoal places immediately above and below the canal.

In itemizing the expenditures for the year, the same classification of work will be adopted as has been in use for the past five years, and is as follows:

Canal.—Operation and care of locks and similar structures, maintenance of embankment, dredging, and care of canal trunk.

Railway.—Maintenance of way, rolling stock, repairs, etc., operating expenses.

Telephone line.—Operation and repairs.
Machine shop.—Operation and repairs.
Sawmill and carpenter shop.—Operation and repairs.
Buildings.—Improvements and repairs.
Quarters and grounds.—Care of, etc.
Floating plant.—Operation and repairs.
Dry dock.—Operation and repairs.
Extraordinary expenditures.—Repairs due to storm damage.

CANAL.

Operation and care of locks, etc.—The operation of the locks requires the services of 11 lockmen, 10 of whom get $35 a month, and the other (lockman at Lock 1), having other duties as engineman on dredge and derrick boats, gets $45 a month. At such times as the latter is on extra duty an extra man is placed on day duty at Lock 1. Each lockman is required to keep the grass and weeds cut and make ordinary improvements on the grounds around his lock and on the towpath for 100 yards above and below.

The drop gate at Lock 9 being troublesome to operate, on account of the instability of the timber frame that held the manipulating gearing and upon which the gate rested when down, a steel frame resting upon stone base blocks was substituted. No further trouble from that source has occurred. Steel frames will be placed under the remaining drop gates, being the upper gates at Locks 5 to 8 inclusive, whenever signs of deterioration in the present frames appear.

The valves at all the locks were originally fastened to the shafts with set screws. These are not heavy enough to stand the shearing strain that falls upon them in opening and closing the valves. Whenever one shears off it is replaced with steel pins, of larger size than the set screws, that pass entirely through the shaft and the hub of the valve. During the year pins have been put in one valve at Lock 6, two at Lock 3, one at Lock 5, and two at Lock 2.

The sand-blast outfit had, at the beginning of the year, cleaned all of the lock gates for repainting, except at Locks A and B. It was desirable to do this work at as low a stage as possible, in order to get as low down as possible without building cofferdams. Accordingly, as soon as the water got low in the fall, the work was taken in hand. The work was interfered with by cold weather and high water, and considerable delay was caused by the passage of boats, one boat making one round trip a week, and others passing occasionally. The total area cleaned and painted was 10,784 square feet, and the cost, including labor drying sand, cleaning and painting, and cost of coal, paint, etc., was—

Labor	$619.98
Coal, paint, and other materials	160.00
Total	779.98
Cost per square foot, approximately	.07

Upon completion of the work the outfit was brought to headquarters and dismantled, in order to save the expense of keeping afloat the barge on which the plant was installed. The barge is too rotten for further service.

The Parker gate, used for a drift sluice above Lock A, had been down since January, 1901. When the water reached a low stage in the fall a temporary plank dam was placed across the opening to ascertain the trouble. The gate was found to be entirely worn-out—parts of it gone. A cofferdam, 16 feet square in cross section and 100 feet long, was built on the upstream side, and an earth dam about 6 feet high on the lower side. All of the timber work was replaced, except a few sticks in the bottom. Twenty thousand two hundred and forty-three feet B. M. of lumber was used in the work. The cost, including building and removing cofferdam and temporary dam and tearing down and rebuilding the gate, was for labor and materials, $1,780.59.

DETAILED STATEMENT OF REPAIRS ON LOCKS.

Lock A.—Ground valves for and packed hydraulic machinery, made valve covers, cleaned and painted gates, repaired walkway and water boxes, made brass packing, and otherwise repaired hydraulic machinery and cleaned mud out from behind gates.

Lock B.—Cleaned and painted gates.

Lock 1.—Cleaned out mud and repaired maneuvering gear; repaired grating coverings for culvert openings.

Lock 2.—Repaired walkway and put steel pins in valve.

Lock 3.—Put steel pins in valve; refitted upper cushion sticks.

Lock 4.—Removed logs from valves.

Lock 5.—Put steel pins in valve.

Lock 6. —Put steel pins in valve; repaired drop gate and waste gate.

Lock 7.—Repaired spar platform, walkway, and hand railing; cleaned out drift.

Lock 8.—Cleaned out drift.

Lock 9.—Put steel frame under drop gate, repaired tank, and put in two new air tanks.

Unit cost of operating and care of locks.

Month (1901-2).	Cost per lock.[a]	Vessels through canal.		Month (1901-2).	Cost per lock.[a]	Vessels through canal.	
		Number.	Cost per vessel.			Number.	Cost per vessel.
July	$60.52	27	$24.66	March[b]	$45.33	23	$21.68
August	50.14	26	21.21	April	40.18	17	25.99
September	40.86	25	17.98	May	47.76	13	40.41
October	50.23	14	39.47	June	41.99	10	46.18
November	99.37	20	54.65				
December	114.29	17	73.95	Average per month	65.01	19	37.48
January	120.29	26	50.89				
February	69.19	11	69.19				

[a] Includes cost of rebuilding drift sluice gate at upper division.

[b] March 29 to June 5 canal empty from Lock 6 to Lock 9.

Total number of lockages, 2,873.

Maintenance of embankment.—Sixteen leaks occurred in the embankment, but were promptly stopped without serious damage. Several leaks in the bed of the canal were stopped, one of which, in the pool between Locks 2 and 3, required 300 cubic yards of gravel to fill. Stopping it effected a great saving in the time of filling the pool, as well as in water for operating purposes below. Other smaller leaks in the same pool and in the pool between Locks 7 and 8 were dug out and tamped with gravel.

Repairs to dam between Miltons Bluff and Browns Island, under project approved November 12, 1900, were completed in the fall, and was the subject of a special report under date of March 24, 1902. The work resulted in an increase in the depth of channel immediately above the dam of approximately 1 foot—just how many inches it is impossible to state. Unfortunately, no gauge had been maintained in the vicinity of the dam for comparison, before and after the work, with the gauge in the river about half a mile below the dam. Such a gauge would have given absolute information as to the benefit of the improvement. Instead the Lock A gauge had to be used. That is in the canal about 2 miles below the dam, where the water surface is subject to a fluctuation of a foot or more from raising and lowering the drift sluice gate. There is no doubt that navigation has been benefited and that the controlling point between Lock A and Decatur has been shifted from the angle of the dam to some other place, probably the foot of Willard Chute. This latter shoal is, I think, too far above the dam to have been affected by the work. Steamboat men have declared the improvement a good one, and as their complaints first called attention to the need of it, so must their commendation be taken as the measure of its success. The work is of a stable character and has stood the unusual number of high waters of the year without breaking at any point. Work done during the fiscal year was 128 cubic yards of stone quarried; 998 cubic yards of riprap broken; 1,367 cubic yards of stone and 1,915 cubic yards of clay placed on the dam; total cost for the year, $2,059.98.

Twice during the year it was necessary to make a thorough cleaning of the drift from the long side wall above Lock A.

Dredging.—The canal trunk was dredged the full width of the canal and down to solid rock from its mouth to Lock 1, and from Lock 1 to Second Creek one cut and part of another was made. The latter reach was dredged to 5.5 feet at extreme low water wherever rock did not interfere.

The following table gives the monthly work performed by the dredge and its cost, which includes wages of operatives, running repairs, and materials expended:

Statement of dredging.

Month.	Classification.	Wages of operatives and material expended.	Cost of repairs.	Cubic yards dredged.	Cost per cubic yard.
1901.					
July	Mud and gravel		$10.46		
August	do		31.19		
September	do		71.27		
October					
November	Mud and gravel	$384.35	33.34	12,400	$0.033
December	do	82.38		1,500	.054
1902.					
January	Mud and gravel	345.83	47.17	11,600	.034
February	do	312.67		11,100	.028
March	do	312.61	9.91	13,250	.024
April			5.38		
May					
June	Mud and gravel	107.40		5,914	.019
Total		1,555.24	208.72	55,764	[a].031

[a] Average for the year.

When navigation was reopened in June it was discovered that a bar had formed in the entrance to Lock 9 that would be bare at low water. The dredge was immediately sent there. Three bars between Lock 6 and the aqueduct were also removed, and one in section 21. The dredge then returned to the pool between Locks 1 and 2.

Unit cost of maintenance of canal trunk and embankment.

Month (1901-2).	Cost per mile of canal.[a]	Vessels through canal.		Month (1901-2).	Cost per mile of canal.[a]	Vessels through canal.	
		Number.	Cost per vessel.			Number.	Cost per vessel.
July	$51.13	27	$34.09	March	$24.82	23	$19.42
August	18.69	26	33.69	April	21.24	17	22.49
September	41.87	25	30.14	May	10.95	13	15.16
October	50.28	14	64.64	June	37.57	10	65.41
November	38.22	20	34.39				
December	11.20	17	11.86	Average per month	31.05	19	29.42
January	25.78	26	17.85				
February	30.92	11	50.59				

[a] Includes cost of repairs to Miltons Bluff-Browns Island dam. Length of canal trunk and embankment, 18 miles.

TELEPHONE LINE.

The United States owns a telephone line from Lock 6 to Florence, Ala., connecting with the central office in the latter place, and another line from Lock 9 to Lock A. The total length of the two is about 33½ miles. The Florence line goes on to Center Star, Ala., about 7 miles farther, that part of the line being owned by Mr. J. T. Jones, of Center Star. The service had become so poor that last fall an expert was sent out from Chattanooga to repair the system. It was somewhat improved for the time being, but soon lapsed into an unsatisfactory state. The instruments were of the earliest make and had been in use for twelve years or more without the care of anyone who understood keeping them up. It was decided to install new instruments of the long-distance type and to double the wires, giving a metallic circuit. Materials for the purpose are on hand and the work is under way. When completed it will be an up-to-date system.

The lines have been in operation throughout the year, except for a few days after the storm of March 28 and for a few days at a time during the high-water periods of the year. Breaks often occur in times of high water where the line crosses from Lock 1 to the left bank of the river The crossing is made from one towhead to another. The spans are excessively long and allow the line to sag so close to the water that drift, borne on high stages, catches the wire and breaks it. It is proposed to put in several timber cribs between the towheads and to plant high poles in the cribs. These will shorten the spans and carry the wire out of reach of drift.

Cost of operation and maintenance of telephone lines.

Month (1901-2).	Cost per mile.
July	$0.433
August	.720
September	.666
October	.407
November	.333
December	.333
January	.645
February	$0.500
March	.614
April	.500
May	.500
June	.690
Average per month	.528

RAILWAY.

Maintenance of way.—Work incident to keeping up 15 miles of railway was done, grass and weeds kept down, roadbed surfaced, and ties tamped. The track was raised and ballasted with cinders the full length of the locks at Locks 1, 2, 3, 4, and 5. Three thousand six hundred and forty-eight ties were renewed during the year.

Rolling stock.—The rolling stock was pretty thoroughly overhauled. The car used for transporting employees to and from work was practically rebuilt and on better lines than the old one, and is now comfortable and substantial. Locomotive No. 5 had new tires put on driving wheels and was generally repaired, except as to tubes in the boiler. The tubes are on hand now and will be put in at the first opportunity. Locomotive No. 4 was also overhauled. New tires and tubes are on hand for it and will be put on soon.

All of the timberwork on four flat cars was renewed. That these repairs were timely was demonstrated when the storm damage of March 28 made it necessary to use both locomotives and all of the flat cars daily, transporting men and materials to repair the damage.

Unit cost of operation and maintenance of railway.

Month (1901-2).	Cost per mile maintenance of track.[a]	Miles run by engines.	Cost per engine mile.[b]
July	$40.94	1,666	$0.087
August	40.78	1,950	.074
September	35.19	1,912	.075
October	3.33	1,993	.076
November	9.07	1,980	.072
December	17.91	1,934	.074
January	20.71	2,051	.070
February	12.01	2,054	.073
March	20.24	1,984	.079
April	6.58	2,762	.082
May	13.65	2,160	.100
June	18.05	2,134	.086
Average per month	19.84	2,048	.079

[a] Length of track and sidings, 16 miles.

[b] For operating expenses.

MACHINE SHOPS.

Operation and repairs.—Most of the work done in the machine and blacksmith shops is chargeable to some other class of work. Tools and machinery have been kept in good repair. The shops were painted inside. Twenty-five new flasks were made for the foundry and the patterns were moved into another building and classified. There is not enough foundry work to keep a molder regularly employed, so the machinist attends to it. When some castings of intricate pattern were to be made last fall, authority was obtained to employ a molder for ten days. The castings cost less than if bought from an outside shop and at the same time the molder worked the sand into good shape and gave some good points on handling the foundry.

SAWMILL AND CARPENTER SHOPS.

Operation and repairs.—The mill and shops were painted. The belting, which had during the preceding year been substituted for the bevel gearing, became inefficient, due largely to the small shafting and improper arrangement of pulleys. Under high speed and with the saw making an average cut, the pulley shafts bent and allowed the belts to slip. Instead of making 600 revolutions, as it should, the saw would make 250 revolutions a minute or less, become rim-bound and either saw the lumber very crooked or refuse to go at all. It was impossible to saw more than 1,500 feet B. M. a day with it. The old bevel gearing was put back and no further trouble was had with it. The saw now cuts from 5,000 to 6,000 feet a day.

The sawmill operatives have other duties to perform, and only work in the mill when a bill of lumber is to be gotten out.

The following table shows the amount and cost of lumber sawed and planed:

Amount and cost of lumber sawed and planed.

Month.	Sawed.		Planed.	
	Feet B. M.	Cost per M.	Feet B. M.	Cost per M.
1901.				
July	11,828	$2.59	10,340	$0.87
August	10,868	2.60	3,542	2.50
September	21,034	3.12	1,450	1.82
October	6,630	3.08	7,443	2.19
November	13,231	2.92	....	....
December	19,043	2.04	9,844	3.06
1902.				
January	8,538	2.57	2,830	2.42
February	6,525	2.46	3,700	1.88
March	4,000	1.56	1,200	2.79
April	11,303	2.69	825	3.86
May	10,368	3.13	....	....
June	13,785	2.89	10,789	2.12
Total and average	137,153	2.70	51,913	2.11

BUILDINGS.

Improvements and repairs.—Hard-finish plastering was put on the lockmaster's house at Lock 9.

The following buildings were painted: Lockmaster's house at Lock 9, assistant engineer's quarters, foremen's quarters, laborers' quarters, machine shop, sawmill, carpenter shop, lockman's house at Lock 7, property house, commissary, negro quarters, negro kitchen and dining room, and nine other outbuildings at Lock 6. From one to three painters were employed during good weather, and, in addition to the above work, painted boats, rolling stock, valve covers, window screens, water tank, etc.

Cement floors were put in cellars in assistant engineer's and foremen's quarters.

Most of the lockmen's houses are two stories high, the ground floor lying below the level of the lock grounds. The lower story was not floored when the houses were built. Some of the lockmen have families of seven members. It was necessary for them to use the lower story for dining room and kitchen. This consisted of one large room. No provision had been made for preventing the water that fell on the roof and adjacent slopes of the embankment running through the lower room. As a consequence, the floor often became muddy and was altogether unsanitary. Floors were put in the houses at Locks 3, 4, 5, and 7, which were the only ones whose occupants were numerous enough to compel them to use the lower story. A partition was put across the room, dividing it into kitchen and dining room, and both were ceiled. A stone wall was built to the height of the ceiling, across the end of the lower story next the embankment and faced with ceiling.

Numerous other minor repairs were made to the buildings, but no new ones were added.

Unit cost of repairs and improvements of buildings.

Month (1901-2).	Cost per building.	Month (1901-2).	Cost per building.
July	$3.99	February	$3.51
August	3.99	March	.72
September	2.33	April	2.83
October	.53	May	6.04
November	2.56	June	5.26
December	4.57		
January	6.43	Total cost per building	[a] 42.66

[a] Thirty-nine buildings.

QUARTERS AND GROUNDS.

In addition to the ordinary work of keeping grass and weeds cut, ditches opened, fences repaired, and grounds generally cared for, the following work was done:

Above and around Lock 1 the United States owns about 15 acres of land. This was formerly a swamp covered with a dense growth of trees and undergrowth. During the year it was ditched and cleared, leaving only the best trees standing. The land has dried out, grass has begun to cover it, and besides adding to the attractiveness of the locality it will be more healthful.

Lock 5 is situated about 100 feet from the bluff. A levee about 3 feet wide on top and 5 high connected the upper end of the lock with the bluff. The levee was getting worn to unsafe proportions. Partly to strengthen it and partly to make a shipping yard for parties desiring to ship by steamboats, the space below the levee, 50 feet wide and reaching from the lock wall to the bluff, was filled in with earth level with the top of the wall. More traffic is done from this lock than any other on the canal except Lock 6, and there was formerly no place suitable for piling stuff against the steamboat's coming.

Heavy hauling during the winter, in fact for several seasons, had cut up the road from Lock 6 to the Florence-Huntsville road. The road is about 1¼ miles long. Three hundred cubic yards of chert was placed on it, the ditches opened, new culverts made, and old ones enlarged and extended. The road is now in first-class condition.

Two dry walls and culverts were built in the barnyard at Lock 6, and dry walls were built around two sides of the lower property house to prevent its being undermined by small branches that flow by it. About 600 linear feet of guttering and curbing was placed along the drive in the grounds at Lock 6. A cement walk, entrance, and gate posts were put in the front yard of the assistant engineer's quarters.

FLOATING PLANT—REPAIRS.

U. S. S. Colbert.—A new canvas covering was put on the roof; the boat was painted inside and out, from hold to top; a few minor repairs were made to the machinery and woodwork. The boat is in splendid condition.

U. S. S. Kingman.—Grating covers for hatches were put in to better ventilate the hold; a half bulkhead was run around the boiler and engines and canvas blinds put on from the bulkhead to the roof for protection of the engineman and stoker from cold and bad weather. The engineman's feet were frozen on one occasion before this was done. The sprocket wheels used to be continually breaking. The pattern was changed, dropping one tooth, new wheels cast and put on, and in the eight months they have been in use show no signs of breaking and very little wear; heavier wheel flanges were also cast and put on and the wheel rebuilt; other minor repairs were made, chiefly by the engineman.

Dredge Bucyrus (elevator).—The dredge's hull is in bad condition and will have to be rebuilt during the ensuing year. Therefore only such repairs as were necessary for the season's work were undertaken.

Barge B (now marked U. S. 12).—Was docked, new rakes and head blocks put on, deck patched, and all seams calked. Repairs cost $237.98.

Naphtha launch.—Overhauled engine, made new coupling, and put in new shaft. Cost, $47.12.

Skiffs.—Repaired three. Cost, $11.04.

U. S. S. McPherson.—Repairs to roof and engines. Cost, $33.17.

Derrick boat No. 3.—Was docked and repairs to the amount of $147.43 were made.

The hull is in bad condition and will have to be rebuilt before another season's work is undertaken with it.

Derrick boat No. 4.—Had a single engine attached to the boiler. The crown sheet of the boiler was cracked. It was replaced with a boiler formerly used with the sand-blast outfit, and double-drum hoisting engines, taken from the scrap pile and repaired, were put on. The machinery is in better condition than that taken off, and the hull is in fairly good condition. Cost of repairs, $128.26.

Flatboat.—Calked and repaired to the extent of $10.46.

DRY DOCK.

Operation and repairs.—The following boats belonging to the United States were on the dock for repairs during the year: Two barges, 1 derrick boat, and dredge *Kentucky*. Mud was cleaned out of the dock and from behind the gate. No repairs were made.

EXTRAORDINARY WORK DUE TO STORM DAMAGE.

March 28, 1902, there occurred a storm of unusual violence that wrought heavy damage to the canal. The rainfall was the heaviest ever recorded for this section. At Riverton, Ala., the rainfall for twenty-four hours was 7.15 inches, and at Shiloh battlefield, about 30 miles farther down the river, it was about the same. At Florence only 2.5 inches was recorded. The heaviest rain probably passed to the northwest of Florence and across the heads of the drainage basins of the creeks that cross the canal. While at Lock 6 the rainfall was heavy, it could not be said to be unusual.

Two extra watchmen were placed on duty that night for fear of danger from Six Mile Creek. A number of steamboats, two costly dredges, and some other floating plant were in the level crossed by that stream, and it was for the care and protection of these that the extra watchmen were detailed. At 10 o'clock, when the overseer retired, everything was all right. Two hours later a watchman reported water running over the railroad track at the roundhouse just below Lock 6. This water came from Shoal Creek, about a mile below, and showed that the creek was about 3 feet above the top of the aqueduct in which the canal crosses the creek.

Comparison with past floods.—In March, 1897, the Tennessee River reached a higher stage in this vicinity than ever before recorded. Heavy rains fell all over the surrounding country and continued for several days. At that time Shoal Creek barely touched the bottom of the aqueduct. Once before, when the last span of the aqueduct was building, the creek rose probably a foot on the side of the aqueduct, but no damage resulted from either of those rises. Several days elapsed between the beginning of the rise and its crest, and the drift had practically all run out of the creek before a dangerous stage was reached. On March 28, this year, Shoal Creek passed from an ordinary stage at dark to a raging torrent, and the crest of the rise, at midnight. It got about 3 feet above the top of the aqueduct, or 10 feet higher than the rise of 1897. The discharge of the creek this year must have been immensely greater than in 1897, for then the river was full and its water backed up into the creek, while this year the river was low and the discharge of the creek freer. The current of the creek showed over half a mile into the river.

Drift.—The banks of the creek are heavily timbered from its headwaters to its mouth. The water came with such a rush that great quantities of drift were brought down. Trees as large as 4 feet in diameter came, roots and all. The open space beneath the aqueduct was clogged with it, and when the water began pouring over its top the heavy trees acted as battering rams on the upstream side of the aqueduct.

The banks were left a tangled mass of drift, principally uprooted trees lodged against those that were left standing. This will be a menace to the aqueduct during rises in the creek for years to come. As the uprooted trees decay and dry out they will be easily dislodged by floods and will be brought down on the aqueduct. Every precaution will be taken to guard against damage from this source. Drift will be cleared away after every rise and the aqueduct will be watched during floods.

It may not be out of place to state that the surrounding country suffered severe losses from the flood. Lauderdale County, in which the canal is, lost six of its eight metal highway bridges; old mills that had been landmarks since the early settlement of this neighborhood were washed away; traffic was suspended on one of the railroads for more than a week, and on another for several days.

DAMAGES.

The next morning disclosed the following damages: The upstream side of 9 bays of the aqueduct was broken off through the angles that connected the sides and bottom; the side was torn apart in bay lengths and cast over into the aqueduct; the masonry of 9 piers and 1 abutment was dislodged for from three to six courses down; several other piers were damaged and the upstream sill was torn off; the heavy trussed wood side fenders were broken off for 9 bays on the upstream side and 15 bays on the downstream side, the latter being swept away; the railway bridge on the lower side of the aqueduct was swept away. This consisted of 26 spans with two 20-inch I-beams to the span, topped with sawed ties and double guard rails. The ties, railroad rails, and guard rails are a total loss. All of the I-beams have been recovered. Some of them were found half a mile from the aqueduct. When it is known that the beams weighed about 2,000 pounds each, some idea can be had of the current that bore them so far.

Breaks were made in the canal embankments just above the aqueduct, one from the creek into the canal and the other from the canal into the river. The former was 50 feet wide, the latter 100. Another break 300 feet wide occurred a thousand feet below Lock 7, and at that place half the bank for 400 feet more was washed away. From 500 feet below Lock 7 to Lock 8 the railroad track was washed off the towpath, a thousand feet of it being a total loss. For the same distance the riprap was washed from the canal side of the towpath. No other breaks occurred, but the embankments were badly washed between Locks 6 and 8 and 2 and 4. Timber frames under bridge over Bluewater Creek were washed away. Three dump scows belonging to the lower river dredging outfit were in the pool between Lock 7 and the aqueduct. They were tossed over the embankment and one was left perched on top of two lock walls of the old Alabama State Canal. Two barges, dredge *Harwood*, 1 quarter boat, and snag barge were left stranded in the trunk of the canal below Lock 6.

No lives were lost in the flood. The lockman at Lock 8 waded with his family through water knee deep to a boat and escaped to the hill. The lockman at Lock 7 was cut off on all sides and sought refuge with his family on the lower valve cover. The water rose halfway up the side of the cover.

REPAIRS.

The first aim of the repair work was to reopen navigation, to do everything to that end first, and let the rest follow. It was also decided by you that wherever weakness had been developed by the flood, extra strength should be given in the repair work. Word was sent through the country of the need of stonecutters, laborers, etc., and in a few days all the men who could be advantageously employed were at work.

Aqueduct.—A contract was let to Walsh & Weidner, of Chattanooga, Tenn., to repair the metal work on the damaged side of the aqueduct. Their mechanics arrived April 21 and worked until May 10, when they were recalled to Chattanooga to await the arrival of the angle iron. They returned to work May 19 and finished their contract May 31. But for the failure of the angle iron to come promptly, navigation could have been reopened on or before May 20. The angle iron was on the way from Pittsburg a month.

Navigation was declared reopened June 5, and on that date the U. S. S. *Kingman* went through from Lock 6 to Lock 9. The work performed by Walsh & Weidner was as follows: Three thousand seven hundred and sixty-three rivets cut out, 176 set screws removed, 4,787 rivets furnished and driven, 540 set screws and screw bolts furnished in place, 3,254 new holes drilled for set screws and rivets, 381 pounds of plates and bars furnished, delivered at Lock 6, and 36½ days' time of mechanics doing extra work, such as straightening and flanging sheets, fitting and patching beams and placing them in their supports in piers; fitting sheets to I-beams; fitting and cutting angle iron, and fitting braces and cover plates. Labor to the amount of $148.33 was furnished to assist mechanics. Employees of the United States also made new U-bolts and side braces, straightened outside bottom beams and connecting bottom plates; made ends and drilled ends for extra U-bolts, built scaffolds, repaired tools, erected derricks, etc.

It was evidently supposed in designing the aqueduct that the water would never get upon the side of it, for, while ample provision has been made against the hydrostatic pressure of water contained in the aqueduct, but little provision has been made against strains from the creek toward the inside. In replacing the damaged parts additional strength was designed in making the braces for the bottom side beam heavier and of angle iron assembled in the form of built-up tees. An extra U-bolt attaching to the top I-beams, and passing around the upstream side of the pier will be put in at each pier. An anchor rod about 7 feet long was in that part of each pier lying above the side of the aqueduct. It has been proposed to put three anchor rods of greater length than the old ones in each pier. The metal work, especially the bottom I-beams, are very rusty, the rust standing out in blisters, upon the removal of which deep pits were disclosed. It was decided to scrape all the metal work and cover it with gas-house pitch, heated before application. Parts of the metal work, covered with pitch when the aqueduct was built, are as well covered to-day as when it was put on, while no sign of paint, put on at the same time, is left.

Railroad bridge.—The 20-inch I-beams were scattered over a space one-fourth by one-half mile in the Tennessee River, at the mouth of Shoal Creek. They were all bent, some of them badly. All of the I-beams were recovered and straightened by screw power and hammering, in a device gotten up for the purpose, and put back on the piers.

Masonry.—It was thought that the stonework on the aqueduct would be the point of delay. Every effort was, therefore, directed toward pushing that part of the work. A quarry was opened up about 2½ miles above Lock 6, at the only accessible place where anything like suitable stone could be procured. Stonecutters were on hand to dress the stone as fast as the quarry could produce it. Twenty-nine stones from the quarry and 19 of the old ones, recut, were needed, together with about as many more that were not damaged, to rebuild the piers, abutment, and sill. The stones were laid in Portland cement mortar, mixed in the proportion of 1 part cement to 2 parts sand, and the joints pointed with a 1 to 1 mixture.

EMBANKMENTS.

Above aqueduct, south side.—The break at this place was filled partly by train, getting earth from a borrow bank just below Lock 4, and partly by wheelbarrows with gravel and clay from a small bank between river and embankment. A dry wall of the length of the break (100 feet) originally faced this embankment on the canal side. This wall was rebuilt, but of larger cross section. It is 16 feet high, 8.5 feet thick at base, and 3.5 feet wide on top. It is also proposed to cover the river side of the embankment with hand-laid paving, 18 inches thick. About half of the paving is laid.

Above aqueduct, north side.—This break was filled by wheelbarrows with clay and gravel taken from the canal trunk from 50 to 100 feet above.

At Lock 7.—This break was filled by wheelbarrows with clay and gravel from the triangle of lowland between the canal, Shoal Creek, and the hill. Average haul was about 200 feet.

The levee opposite Lock 7, connecting the lock and the hill, was filled in the same manner as the above break. Its purpose was to keep the high waters of Shoal Creek from passing behind Lock 7 and entering the canal below. At your suggestion, this will be converted into a paved weir to take care of a part of the water of Shoal Creek. Its crest will be at about the same elevation as the bottom of the aqueduct, and will relieve the aqueduct by increasing the discharge outlet of Shoal Creek at stages that are dangerous. The water so carried off will be discharged into the river over another weir between Locks 7 and 8.

Below Lock 7.—Here was the worst break, requiring the most material to fill and the most inaccessible place. A bluff bank 100 or more feet high is along the land side, and no land lies between the towpath and the river. The trunk of the canal furnished about 50 per cent of the material; for the rest, there was nothing to do but wheel it from the hill to the face of the bluff, dump it into the canal trunk, and rehandle it with wheelbarrows. Where the break was the new embankment was covered with broken stone. That on the river side will afterwards be leveled and a dry wall laid in its place. The canal side for about 600 feet will be paved.

The following is a summary of the classes and cost of work done in repairing storm damage:

Aqueduct.

Ironwork:	
Walsh & Weidner's contract	$645.39
Other work on metal	1,094.79
Stonework:	
79 cubic yards stone quarried, at $2.30	181.70
237 cubic yards stripping, at 44 cents	105.32
38.3 cubic yards stone cut, at $11.82	452.70
Special cutting, slats, etc	269.23
62 cubic yards masonry set	213.78
Clearing up wreckage, building derricks, and other preparations	465.33

Embankments.

Levee and adjacent embankment at Lock 7:	
4,112 cubic yards earth wheeled, at 15.7 cents	646.09
147 square yards paving laid, at $1.08	159.31
Above aqueduct, south side:	
1,872 cubic yards earth transported on cars; 1,250 cubic yards rock, clay, and gravel wheeled; 3,122 cubic yards, at 21 cents	643.55

Above aqueduct, south side—Continued.	
438 cubic yards dry wall built, including stone quarried, excavation for foundation, and other preparations	$1,089.83
432 square yards paving, 18 inches thick, laid (75 square yards relaid), including cost of quarrying stone, at $2.10	907.20
Above aqueduct, north side:	
795 cubic yards earth wheeled, at 18.3 cents	145.60
43 cubic yards paving blocks quarried, at $3.09	132.95
Below Lock 7:	
9,920 cubic yards earth wheeled (4,305 cubic yards handled twice)	2,847.54
321 cubic yards stone quarried	127.36
445 cubic yards gravel wheeled from bar in river for surfacing roadbed	220.05
At Lock 2:	
1,684 cubic yards earth transported on cars for repairing embankments, at 32 cents	370.60
1,600 square feet of embankment slopes graded and planted in Bermuda grass	176.00
Repairs to embankments at other places	32.28
Railway:	
Repairs	929.13
Operation	563.78
Office	151.67
Holidays and lost time	476.75
Subsistence	2,656.22
Miscellaneous	531.97
Tools, materials on hand, etc	470.76
Total	16,706.88

Very respectfully, your obedient servant,

W. S. WINN, *Assistant Engineer.*

Maj. JOHN G. D. KNIGHT,
Corps of Engineers.

C C 3.

IMPROVEMENT OF FRENCH BROAD RIVER AND LITTLE PIGEON RIVER, TENNESSEE.

* * * * * * *

No work upon the French Broad River was undertaken during the past year. The funds available were not sufficient to make it economical and advantageous to do so.

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Money statement.

July 1, 1901, balance unexpended		$2,467.31
Amount appropriated by river and harbor act approved June 13, 1902		15,000.00
		17,467.31
June 30, 1902, amount expended during fiscal year		1,064.70
July 1, 1902, balance unexpended		16,402.61
July 1, 1902, outstanding liabilities		355.27
July 1, 1902, balance available		16,047.34
Amount (estimated) required for completion of existing project		65,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902.		
For works of improvement	$20,000.00	
For maintenance of improvement	2,000.00	
		22,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

The following appropriations have been made by Congress for improving French Broad River, including the Little Pigeon River in Tennessee, viz:

Act of—		Act of—	
June 14, 1880	$10,000	July 13, 1892	$15,000
March 3, 1881	3,500	August 18, 1894	7,000
August 2, 1882	5,000	June 3, 1896	5,000
July 5, 1884	3,500	March 3, 1899	5,000
August 5, 1886	6,000	June 13, 1902	15,000
August 11, 1888	10,000		
September 19, 1890	10,000	Total	95,000

The total amount expended to the close of the fiscal year ending June 30, 1902, was $78,597.39.

COMMERCIAL STATISTICS.

French Broad River, Tennessee.

Articles.	Year ending Dec. 31, 1901.		Articles.	Year ending Dec. 31, 1901.	
	Tons.	Estimated value.		Tons.	Estimated value.
Brick	55	$200	Lumber	6,720	75,000
Coal	550	1,100	Marble	50,000	500,000
Fertilizer	155	3,100	Produce	265	32,887
Flour	1,000	45,000	Sand	36,750	25,725
General merchandise	1,015	111,650	Shingles	4	1,200
Grain	2,711	76,050	Wood	890	1,335
Hay	2,853	45,145			
Live stock	22	1,540	Total	103,340	922,082
Logs	350	2,100			

All of the logs (350 tons) were floated down in rafts.
Of the lumber 80 tons were floated down in rafts.
Number of passengers transported (1901), 3,100.

Details of freight and passenger traffic on the French Broad River between Leadvale, Tenn., and mouth and to points below mouth.

[Distances given are on the French Broad only.]

	Miles.	Passengers.	Tons.
Leadvale and Knoxville	69.5	3,100	14,242
One mile above mouth to 1 mile below Knoxville	1		74,999
One mile above mouth to Knoxville	1		11,751
Rafted			430
Miscellaneous			1,918
Total		3,100	103,340

The above table shows that 84 per cent of the tonnage for 1901 was transported a distance of about 1 mile.

Of the 6 steamboats reported in the last annual report as plying on the French Broad River, 2 were not in this service during the year, and the number of barges was reduced from 27 to 25.

No additional boats were put on.

The total number of craft operating in the river during the year ending December 31, 1901, was 4 steamboats, of a total of 258 tons burden net, and 25 barges, of a total capacity of 1,094 tons.

These steamboats are also reported as plying on the Tennessee River above Chattanooga, Tenn., and one of them also on the Clinch River.

C C 4.

IMPROVEMENT OF CLINCH RIVER, TENNESSEE AND VIRGINIA.

* * * * * * *

The only expenditures during the year were for care of property.

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Money statement.

July 1, 1901, balance unexpended	$3,289,37
Amount appropriated by river and harbor act approved June 13, 1902	3,000.00
	6,289.37
June 30, 1902, amount expended during fiscal year	1,166.55
July 1, 1902, balance unexpended	5,122.82
July 1, 1902, outstanding liabilities	481.42
July 1, 1902, balance available	4,641.40

The following appropriations have been made for this improvement:

Act of—	
June 14, 1880	$10,000
March 3, 1881	3,000
August 2, 1882	3,000
July 5, 1884	5,000
August 5, 1886	5,000
August 11, 1888	5,000
September 19, 1890	4,000
July 13, 1892	$4,000
August 18, 1894	2,500
March 3, 1899	8,500
June 13, 1902	3,000
Total	53,000

COMMERCIAL STATISTICS OF CLINCH RIVER, TENNESSEE.

Articles.	Year ending December 31, 1901.	
	Tons.	Estimated value.
Brick	73	$318.00
Coal	900	1,800.00
Fertilizer	158	3,160.00
Flour	720	32,377.50
General merchandise	5,498	594,548.40
Grain	8,103	212,841.80
Hay	2,255	31,637.38
Iron ore	50,000	62,500.00
Live stock	207	$14,448.00
Logs[a]	68,746	549,970.00
Lumber	665	8,312.50
Produce	986	97,840.00
Sand	25,500	17,850.00
Stone	775	5,500.00
Total	164,586	1,633,103.58

Number of passengers transported (1901), 3,788.

[a] Sixty-eight thousand seven hundred and six tons of the logs reported above were floated down in rafts. The logs and 13,178 tons of other articles included in the above statement are the only items reported as moved on the Clinch River above Kingston. The rest of the commerce reported in the table was between Kingston and points on the Tennessee River, Kingston being only four-fifths of a mile from the junction of the Clinch with the Tennessee River.

CRAFT OPERATING IN CLINCH RIVER.

Of the 7 steamboats reported in my last annual report as plying on the Clinch River, the *Onega* and *W. T. Gallaher* were not in this service during the year, and the number of barges was reduced from 25 to 17. No additional boats were put on.

The total number of craft operating in the river during the year ending December 31, 1901, was 5 steamboats, of a total of 445 tons burden (net), and 17 barges, of a total capacity of 1,880 tons. But one steamboat, the *Clinch*, 24 tons burden, and 2 barges, total capacity 150 tons, have plied above Kingston.

C C 5.

IMPROVEMENT OF HIWASSEE RIVER, TENNESSEE.

* * * * * * *

The river and harbor act of June 13, 1902, appropriated $18,000 for improving the Clinch, Hiwassee (to mouth of Ocoee), and Holston rivers, Tennessee. Of this amount $10,000 was allotted for the improvement of the Hiwassee River.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902	$10,000.00
July 1, 1902, balance unexpended	10,000.00
Amount (estimated) required for completion of existing project	61,125.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	5,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

The original estimate submitted in 1875 was increased from 1878 to 1884, inclusive, to $36,500, which amount has been covered by the ten appropriations made for this improvement, viz:

Act of—		Act of—	
August 14, 1876	$10,000	July 5, 1884	$2,500
June 13, 1878	10,000	August 15, 1886	2,500
March 3, 1879	3,000	August 11, 1888	1,000
June 14, 1880	3,000	September 19, 1890	1,500
March 3, 1881	1,500	June 13, 1902 (allotment)	10,000
August 2, 1882	1,500	Total	46,500

COMMERCIAL STATISTICS, HIWASSEE RIVER, TENNESSEE, FROM JUNE 29, 1901, TO DECEMBER 31, 1901.

Articles.	Tons.	Estimated value.	Articles.	Tons.	Estimated value.
Brick	14	$60	Live stock	24	$1,690
Corn	281	7,025	Logs	489	3,910
Cotton	13	2,250	Lumber	200	2,500
Fertilizer	90	9,000	Produce	80	7,456
Flour	16	700	Sand	150	100
General merchandise	198	22,010			
Grain	182	5,506	Total	1,756	62,580
Hay	19	331			

Number of passengers transported, 400.

All of the above logs (489 tons) were floated in rafts, as follows:

Three hundred and forty tons from Charleston, Tenn., to Chattanooga.

Fifty-five tons from Charleston, Tenn., to Raht.

Ninty-four tons from mouth of Ocoee River to Charleston.

The rest of the commerce reported in the above table was from the mouth of the Ocoee River to the Tennessee.

Report was received from but one steamboat, the *Gasconade*, of 74 tons burden, which plied on the Hiwassee River from June 29, 1901, to December 31, 1901. Another boat, the *Ocoee*, plied on the river up to May, 1901, when she was wrecked, and the records lost.

C C 6.

IMPROVEMENT OF HOLSTON RIVER, VIRGINIA AND TENNESSEE.

* * * * * * *

This is the first appropriation made for the improvement of the Holston River.

Money statement.

Appropriation of June 13, 1902	$5,000
July 1, 1902, balance unexpended	5,000

COMMERCIAL STATISTICS.

No steamboats are reported as plying on this river, traffic having been confined to taking rafts down to the Tennessee River.

C C 7.

SURVEY OF THE TENNESSEE RIVER FROM SCOTT POINT TO LOCK A, MUSCLE SHOALS CANAL.

[Printed in House Doc. No. 50, Fifty-seventh Congress, first session.]

Office of the Chief of Engineers,
United States Army,
Washington, November 29, 1901.

Sir: The river and harbor act of March 3, 1899, in the item appropriating $35,000 for improving Tennessee River between Chattanooga and Riverton, provided that of this amount—

> so much as may be necessary shall be applied in the survey of that portion between Bridgeport and Decatur and a resurvey of the remaining portions of said river between the points named, and in making the survey between Chattanooga and Shellmound through that portion of the river commonly called the "Suck," an examination shall be made with a view to the construction of locks and dams suitable for convenient and safe navigation.

In partial compliance with this provision of the act, Maj. Dan C. Kingman, Corps of Engineers, to whom was assigned the duty of making the survey provided for, submitted a report dated January 17, 1900, presenting detailed plans and estimates for improvement of the river at the "Suck," or mountain section, that is to say, of a reach 17.5 miles in length, extending from Chattanooga down to Scott Point, and on March 27, 1900, there was submitted by him a preliminary report on survey of the river between Bridgeport and Decatur. Both these reports were transmitted to Congress, and are printed respectively, on pages 2956 et seq. and 3008 et seq., of the Annual Report of the Chief Engineers for 1900.

I have now the honor to submit the accompanying copy of report dated March 25, 1901, with maps,[1] by Major Kingman, upon survey of the middle section of said river, i. e., from Scott Point down to Lock A, a stretch about 159 miles in length, embracing the reach between Bridgeport and Decatur, and terminating at the upper portion of the Muscle Shoals Canal improvement.

The plan of improvement presented contemplates securing in the improved channels, by open-channel work, a navigable depth of 5 feet at normal low water for a width suitable for navigation, the total cost of the proposed work being estimated at $770,640.

Major Kingman states that it would be possible to complete the entire improvement in about the time required to improve a single one of the shoals, but in his opinion it would be better, in the interest of economy, to extend the work over four or five seasons, in order to avoid the necessity of purchasing a large amount of plant. He is also of the opinion, which was concurred in by the division engineer, Col. Henry M. Robert, Corps of Engineers (now brigadier-general, Chief of Engineers, United States Army, retired), that this section of the river is worthy of being improved by the General Government.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. ELIHU ROOT,
Secretary of War.

REPORT OF MAJ. D. C. KINGMAN, CORPS OF ENGINEERS.

ENGINEER OFFICE, UNITED STATES ARMY,
Chattanooga, Tenn., March 25, 1901.

GENERAL: The act of Congress approved March 3, 1899, provides for—

> Improving Tennessee River between Chattanooga and Riverton, thirty-five thousand dollars, of which amount so much as may be necessary shall be applied in the survey of that portion between Bridgeport and Decatur and a resurvey of the remaining portions of said river between the points named, and in making the survey between Chattanooga and Shellmounds through that portion of the river commonly called the "Suck," an examination shall be made with a view to the construction of locks and dams suitable for convenient and safe navigation.

The Tennessee River is formed by the junction of the French Broad and Holston rivers, at a point about 4½ miles east of the city of Knoxville, in the State of Tennessee. Its course is southwestward for a distance of about 295 miles, thence northwestward for about 131 miles, thence in a northerly direction for about 226 miles, and it finally unites with the Ohio River at the city of Paducah, Ky. The total length of the river, measured along its channel line, is 651.35 miles. Its length is distributed by States as follows: About 388 miles, or nearly 60 per cent of its length, lies entirely in Tennessee; 192 miles, or nearly 30 per cent, is entirely in Alabama; about 48 miles is entirely in Kentucky; 13 miles between Tennessee and Kentucky, and 10¼ miles between Alabama and Mississippi.

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[1] Not reprinted; printed in House Doc. No. 50, Fifty-seventh Congress, first session.

The river drains an area of 40,811 square miles. Of this area about 22,000 square miles are in Tennessee; 7,000 square miles in Alabama, 5,000 in North Carolina, 3,400 in Virginia, 1,800 in Georgia, 1,050 in Kentucky, and 550 in Mississippi.

The improvement of that portion of the river which lies between Chattanooga, Tenn., and Decatur, Ala., was first undertaken by the United States in 1867; for the river and harbor act of that year provided for a survey of the river from Chattanooga to its mouth. In compliance with this act an examination of the river was made by Assistant Engineer W. B. Gaw, under the direction of Maj. G. Weitzel, Corps of Engineers. No instrumental work was done by Mr. Gaw's party except in the mountain section below Chattanooga and at Muscle Shoals.

Nevertheless, his description of the river is valuable and furnishes a means of comparison for the results obtained in the recent survey. Mr. Gaw prepared plans and estimates for the improvement of this portion of the river, so as to secure a low-water depth of 3 feet. The works proposed by him were, in my opinion, entirely inadequate to secure the result desired, and the estimate of cost was exceedingly small. It would have been impossible to prepare a correct and sufficient project with the data at his command.

In connection with the work of restoring the Muscle Shoals Canal, surveys were extended up as far as the head of Browns Island, about 11 miles below Decatur.

In 1891 a detailed survey was made of the mountain section between Chattanooga and Shellmound. The unsurveyed portion of the river, therefore, was that reach between Shellmound and the head of Browns Island, about 136 miles. To cover this portion of the river a properly equipped party was placed in the field in August, 1899. The field work was completed and the party disbanded in October of the same year. The survey was of the ordinary transit and stadia kind, and its object was as follows: To ascertain the length, width, and general topography of the river; to determine the level of its water surface at the time of the survey, and, as accurately as possible, its low-water surface; to ascertain the fall at every shoal; to sound the river, thoroughly locating all obstructions to navigation and ascertaining the character of the bottom; to obtain all reliable data as to the height of floods and any other information that might be of use in preparing plans for its systematic improvement. As above stated, all measurements were made by stadia. The values of the wire intervals were determined and tested from time to time by readings over a carefully measured base. The azimuths were determined and checked by observations on Polaris or 51 Cephei. Two shore-line parties were employed, one for each bank of the river; also two level parties and a sounding party. The work of the shore-line parties was constantly tested by check points. The level work was also constantly checked by cross levels, or water-surface observations, in the pools. Soundings were located by polar coordinates, a stadia rod in the sounding boat being read from the shore. The cross sections were taken at right angles to the current. The soundings were about 25 feet apart on the cross sections, and the distance between the sections varied from 100 to 800 feet, according to the character of the river and the nature and extent of the obstructions to be located. Such topography as could be observed from the crest of the bank was noted and put upon the charts.

The work has been platted, and is shown upon 38 charts, each 2 feet by 3 feet inside the border. In addition, the notes of the survey of 1891, heretofore referred to, were replatted upon the same scale from Chattanooga down to join on with the work of the new survey. This required nine additional charts. Two charts were also prepared from existing field notes to show that portion of the river between Lock A and the head of Browns Island. This makes 49 charts in all. In addition a continuous profile was prepared, and an index map in three sheets drawn to a scale of 1 inch to 6,000 feet. All of these charts have been traced and paper negatives prepared by the solar Vandyke process. All of the tracings[1] are transmitted herewith.

The cost of this survey for field and office work was $5,671.72, or a little less than $42 per mile of river surveyed. For a detailed description of the methods and results of the survey, attention is respectfully invited to the report of the surveyor, Mr. J. E. Hall, which is transmitted herewith.

In my report of January 17, 1900, I submitted a detailed plan and estimate for the improvement of the mountain section of the Tennessee river; that is to say, of a reach about 18 miles in length, from Chattanooga down to Scott Point. This report was published in House Doc. No. 461, Fifty-sixth Congress, first session.

From Scott Point down to Lock A, the upper portion of the Muscle Shoals Canal improvement, is a stretch of river 159 miles in length. For the improvement of this no definite plan exists. The information gained by the recent survey, supplemented by the gauge records at Chattanooga and Decatur which cover a period of about twenty-six years, by the numerous discharge observations which have been had on this portion of the river, by the rainfall record which has been kept by the Department of Agriculture, and by the information given in the notes of the earlier surveys and reconnoissances, is sufficient to enable a definite plan of improvement, with estimates of cost, to be prepared which can be relied upon to secure the results proposed.

As already stated, the portion of the river under consideration, which is called, for convenience, the "middle section of the Tennessee," extending from Scott Point, Tennessee, to Lock A, Alabama, is 159 miles in length. In this distance the river falls 64 feet, or has a mean slope of four-tenths of a foot per mile. The low-water width of this portion of the river varies from 600 to 2,200 feet. The banks are generally from 20 to 25 feet above the low-water level, and the survey shows that there are 29 localities where the depth is less than 3 feet at extreme low water. The total distance thus obstructed is about 13.75 miles, or 8½ per cent of the entire reach under consideration, and upon these obstructed points a considerable part of the fall of the river is concentrated.

This portion of the river is seldom, if ever, obstructed by ice. The high-water velocity, though considerable, is never great enough to be a serious obstruction to navigation. The only obstruction to navigation, therefore, is found in these shoal places where, at low water, the depth is insufficient. The bottom of the river is generally composed of loose rock, gravel and clay, though occasionally it is formed of solid rock in place. The banks are unusually firm and stable; they are covered with large trees, growing nearly down to the low-water level, clearly demonstrating their stable character and the fact that the high-water periods are infrequent and of short duration.

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[1] Not printed.

A comparison of the results of the present survey with the former examinations and reconnoissances indicates that there has been no change perceptible in the obstacles to navigation. The same shoals exist, with the same depth of water upon them, and this is what would be inferred from the character of the bottom and banks of the river. There is little or no bar-making material traveling downward in the river bed; there are no caving banks, and consequently, no changes in the shape of the channel.

Under these conditions, this portion of the river is singularly favorable to improvement by locks and dams. The total fall, 64 feet, could be easily overcome by 6 dams and locks, having an average lift of about 11 feet. The pools would be nearly 27 miles in length, and the banks of the river are high enough to enable such an improvement to be made without overflowing valuable land. If locks were employed of the same size as those at Muscle Shoals, the cost of the improvement would be about $50,000 per foot of lift, or, in round numbers, about $3,500,000. By such an improvement almost any low-water depth in reason could be secured; but, owing to the fact that the depth on the miter sills of the Muscle Shoals Canal is but 5 feet, no advantage would result in a low-water depth greater than this. I am of the opinion that the river is worthy of such an improvement at such a cost, provided it were necessary; but, owing to the abundant discharge of the river, and the very moderate fall, and the comparatively insignificant character of the obstructions, a sufficient depth and a sufficiently moderate current for all purposes of navigation can certainly be secured by an improvement by regulation at a very much less cost than by a slack-water improvement.

It must be admitted that many of the attempted improvements of rivers by regulation have proved disappointing in the end, and it may be worth while to point out briefly the principal causes of failure, in order to show more clearly why the improvement of the middle section of the Tennessee by this method is likely to succeed. The bottom or bed of an ordinary fresh-water river does not consist of a smooth even groove or furrow like a ditch, but is made up of a series of long and comparatively narrow and deep holes or troughs, these holes being separated from each other by ridges, which are generally broad and flat on top, and of such length as to make the river considerably wider where they occur than it is in the deep portions. The crest of any one of these ridges is generally a little lower than that of the one which immediately precedes it upstream. These ridges are the bars or reefs, and are the places where low-water navigation is most inconvenient and difficult. They are in effect a series of submerged dams, which divide the river, when low, into ponds or pools. These pools vary from a few hundred yards to several miles in length, and in them, when the river is low, the water is generally sufficiently deep, the current is gentle, and navigation is free and unobstructed, and the pools are separated by the bars where at low water the river is wide, the water shallow, the current rapid, and where nearly all the fall is concentrated, where snags and bowlders are generally found, and where navigation is in consequence difficult, often dangerous, and sometimes impossible.

This is the condition when the river is low, but as the river rises the condition rapidly changes, for with each foot of added height the area of cross section at the bar, or wide portion of the river, increases more rapidly than the corresponding section in the pool or narrow portion, and at a certain stage, as the water rises, the area of cross section upon the bar will be equal to that in the pool, and as it continues to rise the area on the bar will become greater than in the pool, and the bar section will then be the one affording the greatest freedom to the flow of water, and the pool will become the narrow or constricted portion, and the velocity of the current from having been the greatest on the bar, will change and become the greatest in the pool.

Now, if the river is a silt-bearing one, and if the bottom is covered with material which can be moved by the river at the time when its velocity is greatest, then this material will be picked up during the floods, the pools will be dug out or their banks washed, and the material moved forward by the water until it comes to the bar section where the current is less in consequence of the greater area of discharge, and there a portion of the silt will be deposited and the bar built up, and when the river falls it may happen that the feebler current of the low stage will be insufficient to cut out a navigable channel through the deposited material.

The ordinary method of improving a river by regulation consists in contracting the low-water area of discharge upon the bar in such a way as to elevate somewhat the water in the pool above and to force the flow of the river to take place in a comparatively narrow channel on the bar, whereby a sufficient depth for the purposes of navigation may be obtained. The contraction works are generally of low relief, and produce little or no effect at the flood stages. Therefore in a heavy silt-bearing river it may frequently happen that when the river falls it will be found that the contraction works and the regulated channel have been completely buried up and obliterated by the mass of bar-forming material and the low-water current will not be sufficient to restore the channel.

Another reason for the failure of contraction works is this: If the bottom of the river, and particularly the material which forms the bars, is soft enough to be eroded under a slightly accelerated current, then, when the contraction is completed and the current necessarily increased by reason of the contraction and the greater depth in the improved channel, the effect will be to cut out the bar, and a greater depth and capacity for discharge will result upon the bar section than originally existed. This at first may appear to be an improvement, but the result is almost certain to be a lowering of the water level in the pool above, whereby portions of the bottom of the pool become obstructions, which before were sufficiently covered, or the effect may go on until the entire low-water bed of the river has been lowered, with the result that navigation is no better than it was in the first place. It is true that in the first case the deposit of bar material upon the wide section might be diminished, or perhaps done away with, by making the contraction works sufficiently high and sufficiently extensive to proportionately reduce the high-water area of discharge, and thus prevent the loss of velocity of flow, which resulted from an excessively wide section; and in the second case, the cutting out of the bar and the lowering of the bed of the river might be prevented by suitable works in the form of sills or groins. These works, however, are expensive, and unless provided for in the original estimate will cause the improvement to cost a vastly greater amount than was originally expected.

Now, in the case of the Tennessee River, it is found in the section under consideration, that there is little or no moving material in the bed of the stream. It is also found that the bed of the stream is so hard and of such a firm character that there is little or no danger that it will be cut out by the moderate increase of current which it may be necessary to bring about in order to secure a sufficient depth of water on the bars. This makes it particularly favorable for the proposed improvement, and enables the project to be undertaken with confidence, not only that it will succeed, but that its cost can readily be computed, and will, on the whole, be very reasonable.

The object sought to be attained in the improvement of a river by regulation is to connect the pools, in which the depth is generally sufficient for the purposes of navigation, by channels of a width and depth great enough, and in which the slope of the water and the resulting velocity shall not be too great, for convenient navigation. It is necessary also to be careful not to make these channels so large as to increase the normal discharge through them, whereby the level of the water in the pool above would be unduly lowered.

The means adopted to secure these results are spur dikes and training walls for reducing the width of the waterway on the bars, and for outlining the desired channel. These are supplemented by dredging where the depth is not sufficient, and by the construction of submerged sills or groins, where the depth in the improved section is too great. The dams and training walls are necessarily of low relief, and they are soon drowned out, and their effect is lost as the river rises. It is necessary, therefore, to give to the improved channels such position and direction that the high-water current will conform to that in the regulated channel, and in this way excessive velocity at certain stages of the river and troublesome cross currents, inconvenient and dangerous to navigation, will best be obviated.

In planning the works it is necessary to adopt some particular stage of the river, with reference to which the improvement shall be designed, and to take care that the works shall not be such as to become an obstruction before they have been sufficiently drowned out by the rising of the river.

By examining the gauge records of the Tennessee River it is found that the zero stage is very seldom reached and extreme low-water periods are of very short duration. If the works were planned for the lowest stage of the river the best effect of them would very seldom be seen or felt. It is, therefore, better to select a higher stage for which to plan the work, taking care that the new condition shall be such that navigation will still be possible even at the lowest stages, and that it shall not be rendered difficult at the critical stage which occurs just before the works are drowned out. These considerations render it desirable that a 1-foot stage of the Chattanooga gauge should be selected as the normal low water, or the stage for which the improvement is designed. The river is above this stage about 97 per cent of the time. The discharge at this stage is about 10,000 cubic feet a second.

On account of the depth of water on the miter sills of Muscle Shoals Canal, which is 5 feet, there seems to be no reason for attempting to obtain a greater depth in the regulated channel than this, and the works are, therefore, designed to secure in the improved channels a navigable depth of 5 feet for a width suitable for navigation, and a mean depth of 4½ feet at the normal stage. It is found that these conditions will secure a navigable depth of about 3½ feet at the extreme low-water stage; and that at a 5-foot stage, when the discharge is about 30,000 cubic feet a second, the velocity in the improved channel will not be great enough to be a serious inconvenience to navigation, and that when this stage is passed the contraction works will soon drown out and their effect will entirely disappear.

It is possible to compute mathematically, by means of well-known formulas, the velocity of the water in a channel of known width, depth, and slope, and hence, knowing the discharge of the river at the normal stage and the difference of level to be overcome between the pools, it is possible to design a channel of dimensions to conform to the required depth and slope. In this way the problem of improving the portion of the Tennessee River under consideration has been carefully solved. The work has been done under my direction and supervision by Assistant Engineer G. T. Nelles, and his report is transmitted herewith.

I have carefully considered with him the detailed plans and estimates for each one of the proposed improvements, and I am satisfied that they will produce the result desired. His report is an exceedingly careful, painstaking one and is worthy of special consideration. I regard it in many respects as a model for the solution of problems of this kind.

It is found that the complete improvement will involve the construction of spur dikes, training walls, submerged sills, and bank protection, containing in the aggregate 427,000 cubic yards of broken stone, and stone is everywhere easily obtainable along the Tennessee River. In addition the improvement will require the removal, by dredging, of about 650,000 cubic yards of material.

The total estimated cost of the improvement, including a liberal allowance for the removal of snags, overhanging trees, detached bowlders, and similar obstructions, and a liberal allowance for supervision and contingencies, is $770,640.

It would, of course, be possible to carry forward work of this kind very rapidly and to complete the entire improvement in about the time that it would be necessary to improve a single one of the shoals, but in the interest of economy I think that it would be better to extend the work over four or five seasons, in order to avoid the necessity of purchasing a large amount of plant.

The improvement of the Tennessee River by the United States has been in progress for a period of about fifty years, the first appropriation of money having been made in 1852. The total amount appropriated to date is $5,315,526.03, of which $391,000 has been applied to the river above Chattanooga, and the remainder, $4,924,526.03, for the river below.

From the necessity of the case, a portion of this money has been expended for the purpose of maintaining existing conditions, rather than to the furtherance of the improvement. It has been necessary from time to time to remove snags, overhanging trees, and similar obstructions, and to erect certain works of a temporary character, for the purpose of affording immediate relief to commerce.

A definite project now exists for the improvement of the Tennessee River above Chattanooga. It was prepared by Col. Henry M. Robert, Corps of Engineers, and submitted with his report of February 28, 1893, and has been in course of execution ever since. Its object is to obtain by regulation a navigable channel 3 feet deep at extreme low water, which will give about 3½ feet at the normal low-water stage. The amount necessary to complete this improvement is $550,000. I am of the opinion that this estimate is sufficient.

For the mountain section below Chattanooga a plan of improvement by a lock and dam was submitted, and is published in House Doc. No. 461, Fifty-sixth Congress, first session. The estimated cost of this improvement is $888,624.

The report now submitted provides for the improvement of the middle section of the Tennessee from Scott Point to Lock A, at an estimated cost of $770,640.

The Board of Engineers of 1890 prepared a project for the improvement of Little Muscle Shoals by a lateral canal at an estimated cost of $1,500,000. The plan for the improvement of the Colbert Shoals by a lateral canal was estimated by the Board of Engineers of 1890 to cost $2,500,000. There has already been expended in the furtherance of this project $787,113.84, leaving a balance necessary to complete, in accordance with the original estimate, of $1,712,886.16.

The improvement of the Tennessee River below Riverton is being carried out by dredging, and good progress is being made. It is difficult to give an exact estimate of the amount necessary to complete the work, because the nature of the material to be removed can not be definitely determined until the work at the particular shoal is actually in progress. I am satisfied, however, that $250,000 will be ample to cover the improvement of this portion of the river. There remains, then, nothing but certain unimproved reaches between the upper and lower division of the Muscle Shoals Canal and between Florence and the head of Colbert Shoals Canal to be provided for. A number of minor obstructions, similar in character to those found in the middle section, exist upon these reaches.

There is a little less than 30 miles of river in all in the portion under consideration, and if the improvement by regulation should cost $5,000 a mile, it would require $150,000 to carry it out. The sum total of these estimates is $5,822,150.16. This slightly exceeds the amount given in the last report of the Chief of Engineers as necessary to complete the improvement of the river; but when it is considered that the original estimates were made long ago and based upon very insufficient data, the substantial agreement of the two is rather remarkable.

The total length of the river is 651.35 miles; and, adding to the amount already appropriated the amount estimated as necessary for completion, it gives the sum of $11,137,676.19 as the total to be expended on the river from first to last. This would be an average cost of $17,100 a mile, and would secure a navigable depth at normal low water of 3½ feet between Knoxville and Chattanooga, and 5 feet from Chattanooga to the mouth of the river.

I am of the opinion, however, that the Colbert Shoals lateral canal can not be completed for the amount estimated by the Board of Engineers. My own estimate, as given in my report of August 2, 1899, was $2,748,722, to complete the canal. This amount should be diminished by about $90,000, to represent the value of the stone which has been cut and quarried since the 1899 estimate was made, and this leaves $2,658,722 as the amount necessary to complete this work. This would add $1,400 per mile to the total cost of improving the river, and bring the amount up to $18,500. * * *

It may be of interest to compare the cost of the proposed improvement of this river with that of some of the well-known European rivers. Below (see p. 1753) is given a table compiled from the best obtainable sources, showing the cost and character of the improvement on certain rivers which most nearly resemble the Tennessee. From this it is seen that the improvement of the Oder and the Elbe cost about three times as much per mile as the Tennessee will cost; the Rhone from Lyons to the sea cost more than four times as much; and the Rhine about five times as much, which shows that the cost of improving the Tennessee, although apparently large, is very moderate when compared with the amount expended on other successful river improvements.

Respectfully submitted,

DAN C. KINGMAN,
Major of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, April 4, 1901.

Respectfully forwarded to the Chief of Engineers, United States Army.

I am of opinion that this middle section of the Tennessee River should be improved by regulation, as recommended by Major Kingman in his excellent report.

Last summer I inspected this river, from 50 miles below Knoxville to its mouth, and looked into the question of its worthiness for improvement. The work done heretofore below Chattanooga is of little value at present, and will remain so until the river as a whole is improved. To make the trip below Chattanooga required me to constantly change boats, using four in all, because of the disconnected improved parts. There can be no commerce worth mentioning until there is a 5-foot navigation from Chattanooga to the Ohio.

HENRY M. ROBERT,
Colonel, Corps of Engineers,
Division Engineer.

EXHIBITS.

1.	Report of Mr. G. T. Nelles, assistant engineer	February 5, 1901.
2.	Report of Mr. J. E. Hall, surveyor	October 31, 1900.
3.	Report of Mr. W. B. Gaw, assistant engineer	February 11, 1868.
4.	Extract from report of Maj. Walter McFarland, Corps of Engineers	May 25, 1872.
5.	Extracts from journal of Mr. W. G. Williamson, assistant engineer	June and July, 1875.
6.	Extracts from Annual Reports of Chief of Engineers	1877–1882.
6a.	Extracts from report of Mr. Paul Le Hardy, assistant engineer	January 29, 1877.
7.	Report of Lieut. H. E. Waterman, Corps of Engineers	January 15, 1888.
8.	Report of Mr. W. G. Williamson, assistant engineer	April 6, 1893.
9a.	Report of Lieut. Geo. W. Goethals, Corps of Engineers	October 13, 1891.
9b.	Report of Mr. D. L. Sublett, assistant engineer	September 18, 1891.
9c.	Report of Capt. Geo. W. Goethals, Corps of Engineers	August 5, 1892.
9d.	Report of Mr. D. L. Sublett, assistant engineer	July, 1892.
10.	Extracts from Annual Reports of Chief of Engineers	1892–1897.

10a. Report of Mr. W. S. Winn, assistant engineer..............June 1, 1895.
10b. Report of Mr. W. S. Winn, assistant engineer..............June 7, 1897.
11a. Report of Mr. J. W. Walker, assistant engineer............October 11, 1894.
11b. Report of Mr. J. W. Walker, assistant engineer............October 20, 1894.
11c. Report of Mr. J. W. Walker, assistant engineer............October 24, 1894.
12. Statement of work done during 1900.

Table showing the cost and character of improvement, etc., of certain rivers which most nearly resemble the Tennessee River.

	Length considered.	Fall.			Discharge.			
		Total fall.	Mean rate of fall per mile.	Maximum rate of fall per mile.	Extreme low water.	Normal low water.	Mean.	Flood.
	Miles.	*Feet.*	*Feet.*	*Feet.*	*Cu. f. s.*	*Cu. f. s.*	*Cu. f. s.*	*Cu. f. s.*
All waterways, France	7,612	......	......	......	......	......	......	......
All waterways, England and Wales	4,332	......	......	......	......	......	......	......
Rhone, Lyons to the sea	205.5	520	2.5	25	5,300 13,000	8,500 16,000	*n* 61,000	250,000 490,000
Seine (upper)	63	......	......	......	......	1,700	......	......
Seine (Surene to Marlot)	120	75	.62	......	1,230	......	24,500	60,000
Vistula (in Prussia)	143	......	*a* 3.33	......	*n* 8,766	......	......	*n* 76,700
Oder (Oderberg to Schwedt)	429	......	*b* 1.80 *c* .65	......	......	......	......	......
Elbe (in Prussia)	270	......	1	10	......	*d* 3,150	......	......
Weser (in Prussia)	207	......	......	......	......	......	......	......
Rhine (in Prussia)	224	......	*e* 2.95	......	......	......	*f* 89,000	341,000
The cataracts of the Danube	52.5	76	1.45	21	......	*f* 59,000	......	*g* 600,000
The cataracts of the Dneiper	41.5	109	2.65	53	9,800	17,500	......	805,000
Moska	109	......	.45	......	......	......	......	......
Middle Tennessee, Scott Point to head Muscle Shoals Canal	158.3	61.6	.40	18.5	*k* 3,700 *f* 6,000	*k* 8,455 *f* 10,330	*k* 36,750	*k* 468,000 *l* 508,000

	Kind of improvement.	Normal width of improved channel.	Normal depth of improved channel.	Total cost of improvement.	Cost per mile of improvement.	Remarks.
		Feet.	*Feet.*			
All waterways, France	......	......	......	$240,000,000	$31,530	From 1884 to 1897, inclusive.
All waterways, England and Wales.	......	......	......	96,000,000	22,100	To 1884.
Rhone, Lyons to the sea	Regulation	390 820	5.25 6.50	15,335,000	74,600	From 1846 to 1897, inclusive.
Seine (upper)	Canalization	......	6.56	1,750,000	27,750	
Seine (Surene to Marlot)	....do	......	6.56	8,500,000	71,000	
Vistula (in Prussia)	Regulation	......	5.5 10	3,900,000	27,000	
Oder (Oderberg to Schwedt)	....do	......	3.25	19,400,000	45,000	From 1816 to 1897, inclusive.
Elbe (in Prussia)	....do	300 900	3	13,600,000	50,000	From 1859 to 1897, inclusive.
Weser (in Prussia)	....do	......	2.5 4	1,000,000	5,000	From 1870 to completion.
Rhine (in Prussia)	....do	800 1,350	6.5 10	19,272,500	86,000	From 1816 to 1897, inclusive.
The cataracts of the Danube.	....do	*h* 200 250	6.56 9.84	8,750,000	165,000	
The cataracts of the Dneiper.	....do	105	*h* 5	......	......	
Moska	Canalization	......	......	1,850,000	17,000	
Middle Tennessee, Scott Point to head Muscle Shoals Canal.	Regulation	250 1,200	5	*m* 900,000	5,700	

a, for length of 600 miles; *b*, for length of 550 miles; *c*, for length of 300 miles; *d*, at Torgue; *e*, Lake Constance to Rotterdam; *f*, mean and maximum discharge at mouth; *g*, at D'Orsora; *h*, width and depth of canals in river bed; *k*, Chattanooga; *l*, Riverton; *m*, from Scott Point to angle in dam above Lock A, 158.25 miles, including amounts already expended; *n*, at mouth.

EXHIBIT No. 1.

REPORT OF MR. G. T. NELLES, ASSISTANT ENGINEER, ON IMPROVEMENT OF THE TENNESSEE RIVER FROM SCOTT POINT, TENNESSEE, TO UPPER DIVISION OF MUSCLE SHOALS CANAL.

ENGINEER OFFICE, UNITED STATES ARMY,
Chattanooga, Tenn., February 5, 1901.

MAJOR: Under your immediate direction I have made a careful and comprehensive study of the physical character of the middle section of the Tennessee River, and of the methods usually employed for the improvement of streams of similar character and importance, and now have the honor to submit for your consideration the following report, with detailed plans and estimates of the cost of a desirable improvement:

The section of the river specially considered, and designated as the middle section extends from Scott Point, 17.50 miles below Chattanooga, Tenn., to the head of the upper division of the Muscle Shoals Canal, 2 miles above Lock A, a total distance of 158.3 miles.

The report and maps of a survey from Shellmound, Tenn., to Browns Ferry, Ala., made in 1899 by Mr. J. E. Hall, United States surveyor (Exhibit No. 2, herewith), has furnished most of the information concerning the present condition of the river, within the limits stated, used in this investigation. Above Shellmound the survey made in 1891 by Mr. D. L. Sublett, assistant engineer, under the direction of Capt. George W. Goethals, Corps of Engineers, has been the principal source of information. Between Browns Ferry and the head of Muscle Shoals Canal the surveys made in 1892-93 by Mr. W. G. Williamson, assistant engineer, under the direction of Captain Goethals, have been made use of. The physical and hydrological data given and made use of have been obtained from various sources, and represent the accumulated available information on these questions.

The early maps, notes, and reports, and other records of this office covering this section of the river have been freely drawn on for information of an historical nature, and for the purpose of affording a basis of comparison from which to determine if possible the effect of the works of improvement heretofore undertaken, or the extent of changes in the regimen of the river due to natural causes.

HISTORICAL.

The improvement of this section of the river has been under serious consideration by the officials of the General Government since 1867, when, in compliance with the provisions of the act of March 2, an examination of the river between Chattanooga, Tenn., and Paducah, Ky., was made by Mr. W. B. Gaw, assistant engineer. Mr. Gaw's report to Maj. G. Weitzel, Corps of Engineers, rendered February 11, 1868, is a document of unusual interest, and so much of it as relates to the middle section of the river is transmitted herewith as Exhibit No. 3. Except in the mountain section below Chattanooga, and at the Muscle Shoals, no instrumental work was done by Mr. Gaw's party; consequently the plans proposed, which were designed to give a channel depth of at least 3 feet at extreme low water, were based on insufficient data, and have generally proved inadequate for the purpose.

Mr. Gaw's estimate of the cost of the complete removal of all obstructions affording a depth of less than 3 feet at extreme low water, between Kellys Ferry and Decatur, was $58,901. Major Weitzel, in transmitting this report and estimate to the Secretary of War, stated that he did not consider it adequate, and advised an increase of about 50 per cent.

In 1870 bids were taken for carrying out Mr. Gaw's plans at Widows Bar, Bellefonte Bar, Gunters Reef, Gunters Bar, and Limestone Bar. The lowest bid for this work, which was not undertaken, was $18,275.

In his preliminary report of May 25, 1872, on the proposed lines of water communication between the Mississippi River and the Atlantic Ocean (Exhibit No. 4, herewith), Maj. Walter McFarland, Corps of Engineers, estimated the approximate cost of securing a channel depth of at least 3 feet at extreme low water in the Tennessee River between the head of the Elk River Shoals and Short Creek, 2½ miles above Guntersville, Ala., at $75,000.

Under the terms of the act of Congress of June 23, 1874, Major McFarland was directed to investigate and report on the "Southern routes to the seaboard." In this connection he caused detailed surveys and examinations to be made of every obstruction in the river between Knoxville, Tenn., and the Elk River Shoals, on which there was a depth of less than 3 feet at extreme low water. Mr. W. G. Williamson, assistant engineer, conducted the field work, and in addition to various other surveys made detailed instrumental surveys of Long (Bridgeport) Island, Widows Bar, Crow Creek Shoals, Bellefonte Bar, Larkins Towhead, Sycamore Shoals, and Swafford (Mink Creek) Shoals. At Mink Creek it became necessary to suspend further field operations on account of high water, but by inquiry among pilots and others familiar with the river Mr. Williamson managed to obtain and tabulate much valuable information concerning the other obstructions above Decatur. Mr. Williamson's report and estimate for improving the obstructions examined is not to be found among the records of this office, but from his journal of daily operations during the survey (Exhibit No. 5, herewith), from his notes, and from his very complete and satisfactory maps, it has been possible to learn what his plans for each improvement were, although the quantities and estimated costs are not shown.

In 1876 an examination between Guntersville and Browns Ferry, Ala., and a detailed survey of the left chute at Browns Island—considered to be part of the Elk River Shoals—was made by Mr. Paul Le Hardy, assistant engineer, under the direction of Capt. W. R. King, Corps of Engineers.

In his report (Exhibit No. 6a, herewith) Mr. Le Hardy describes the various obstructions in considerable detail, and submits plans, with estimates of the cost of securing a channel depth of at least 3 feet at extreme low water to the head of Browns Island, amounting to $56,050. He also submits plans and estimates covering the improvement of Browns Island Chute, but these are so involved with the construction of the Elk River or upper division of the Muscle Shoals Canal that they can not easily be separated.

In 1877 work was commenced in Browns Island Chute, in connection with the construction of the Elk River Canal, under the plans suggested by Mr. Le Hardy, and continued until 1882, at which time about 40,000 cubic yards of rock had been excavated from the channel in a distance of about 2 miles, forming two narrow canals in the bed of the river. This work is quite fully described in the extracts from the Annual Reports of the Chief of Engineers, given herewith as Exhibit No. 6, and is also shown on the accompanying maps (pl. No. 6).

In 1887 a reexamination of Browns Island Chute was made by Lieut. H. E. Waterman, Corps of Engineers, under the direction of Lieut. Col. J. W. Barlow, Corps of Engineers. In his report (Exhibit No. 7, herewith) Lieutenant Waterman recommends the abandonment of the channel which had been the object of all previous work, and advised the construction of an entirely new channel along the left bank, involving the excavation of 66,200 cubic yards of solid rock.

In 1891 a detailed survey of this chute was commenced by Mr. W. G. Williamson, assistant engineer, under the direction of Capt. George W. Goethals, Corps of Engineers. This survey was interrupted by high water and other causes, and was not finally completed until late in 1892. In his report, dated April 6, 1893 (Exhibit No. 8, herewith), Mr. Williamson submits plans for a canal 150 feet wide, of excellent alignment, along the line of deepest water. For a depth at low water of 6 feet he estimates the cost at $2,991,648, and for a depth of 4 feet at $1,472,316. He also submitted plans for a lock and dam at Miltons Bluff, designed to give the required low-water depth in the island chute, which he estimated to cost $551,562.50.

During the construction of the Elk River Canal or, as it is now called, the upper division of the Muscle Shoals Canal, and until it had been completed and opened to traffic, nothing was done looking toward the improvement of the middle section of the river. In 1891, however, at the instance of Capt. George W. Goethals, detailed surveys were made by Mr. D. L. Sublett, assistant engineer, at the "Pan," Savannah Towhead, Bridgeport Island, Widows Bar, and Gunters Reef. Based on these surveys and the reports of Mr. Sublett, Captain Goethals submitted the following projects (Exhibits Nos. 9a and 9c, herewith):

October 13, 1891, for the improvement of Gunters Reef, by excavating through it a channel 120 feet wide and 3 feet deep at low water, at an estimated cost of $4,000.

August 5, 1892, for the improvement of the left chute at Bridgeport Island, by the excavation, where necessary, of a channel 120 feet wide and 3 feet deep at low water, and the construction of a dam across the right chute to the head of the island, at an estimated cost of $34,100.

Bids were invited for the execution of these projects and a contract entered into for the work at Gunters Reef, but on account of the excessive price asked by contractors the work at Bridgeport Island was undertaken by hired labor. The work done under these projects and the general project for the improvement of the whole section is quite fully described in the extracts from the Annual Reports of the Chief of Engineers (given herewith as Exhibit No. 10), and the reports of Mr. W. S. Winn, assistant engineer, who was in local charge of the works (Exhibits Nos. 10a and 10b).

The work actually done consisted in the removal of miscellaneous channel obstructions and the excavation of a low-water channel at the cost given below:

Gunters Reef, Beards Reef, Flint River Bar, etc	$12,000
Bridgport Island, left chute	50,000
Total expended, 1891-1899, not including surveys or incidentals	62,000

In 1894, under the direction of Captain Goethals, instrumental surveys were made by Mr. J. W. Walker, assistant engineer, at Beards Reef, Flint River Bar, and Coles Bend. In his report (Exhibits Nos. 11a to 11c) Mr Walker submitted plans for a low-water improvement at the localities surveyed by means of spur dams and channel excavation, designed to give a depth of at least 3 feet at low water, which he estimated to cost as follows:

Beards Reef	$8,905.00
Flint River Bar	9,121.20
Coles Bend	10,854.25
Total	28,880.45

Special projects for these improvements have never been submitted to the Department for approval.

In 1899, under the provisions of the act of Congress of March 3, a comprehensive survey of the river between Shellmound, Tenn., and Decatur, Ala., was made under your direction by Mr. J. E. Hall, United States surveyor. The report and maps of this survey (Exhibit No. 2), as before stated, form the basis of the present investigation.

During the low-water season of 1900, under your direction the U. S. S. *McPherson*, with a derrick boat, went over the middle section and removed many serious obstructions from the channel. The work was in charge of Capt. J. I. Thompson, pilot of the *McPherson*, whose intimate knowledge of the river and the requirements of navigation enabled him to effect a very decided improvement at a moderate cost. The general nature and extent of the work done by him, as well as the resulting channel depths and widths, is given herewith in tabulated form as Exhibit No. 12.

GENERAL DESCRIPTION, CHARACTER, AND HYDROLOGY OF THE TENNESSEE RIVER AND ITS BASIN.

The Tennessee is one of the principal rivers of the United States. It is formed by the confluence of the French Broad and Holston rivers 4½ miles above Knoxville, Tenn. From thence it flows in a southwesterly direction through the States of Tennessee and Alabama to Guntersville, Ala., a distance of 294.5 miles. At Guntersville its course changes to northwesterly, which direction it follows to Riverton, Ala., a distance of 130.85 miles. Below Riverton it makes a decided turn to the right and follows a northerly course for 226 miles, through the States of Tennessee and Kentucky, to its junction with the Ohio River, at the foot of Tennessee Island, at Paducah, Ky.

The total length of the river is 651.35 miles, all of which is navigable the year round for boats of very light draft, and on an average of nine months in the year for boats of ordinary draft, such as are in common use on the river. Commerce is never impeded by ice and rarely by floods.

The total length is distributed by States, as follows: 388.5 miles, or nearly 60 per cent, is entirely in Tennessee; 192.1 miles, or nearly 30 per cent, is entirely in Alabama; 47.5 miles is entirely in Kentucky; 13 miles lie between Tennessee and Kentucky, and 10.25 between Alabama and Mississippi.

For convenience, and for the purpose of designating sections for improvement, it has become customary to divide the river into sections of somewhat similar and uniform character. These are as follows:

TABLE No. 1.—*Showing the customary divisions of the Tennessee River into sections, and character of each.*

Designation.	Extent.		Length.	Fall.	Mean fall per mile.
	From—	To—			
			Miles.	*Feet.*	*Feet.*
Upper section	Source	Chattanooga	188	179.7	0.95
Mountain section	Chattanooga	Scott Point	17.50	27.9	1.60
Middle section	Scott Point	Head of Muscle Shoals Canal.	158.30	63.8	.40
Muscle Shoals Canal	Head of Muscle Shoals Canal.	Lift lock at Riverton	61.55	168.5	2.73
Colbert Shoals Canal					
Lower section	Lift lock at Riverton.	Paducah, foot of Tennessee Island.	226	78.5	.34
Total and mean			651.35	518.4	.80

NOTE.—The head of the Muscle Shoals Canal is assumed to be at the angle in the dam, 2 miles above Lock A.

The upper section has been the subject of several examinations and reports, beginning with that made in 1830 by Lieut. Col. S. H. Long, Corps of Topographical Engineers, U. S. A., published as House Ex. Doc. No. 167, Forty-third Congress, second session, and ending with the complete survey and exhaustive report made in 1891–1893, by Capt. John Biddle, Corps of Engineers, published in the Annual Report of the Chief of Engineers for 1893. These documents describe fully the character and needs of this section of the river.

The mountain section has received considerable attention in the past, and under the provisions of the act of Congress of March 3, 1899, was made the subject of a special study and report. This investigation was made under your direction, and my report to you of January 10, 1900, published as House Doc. No. 461, Fifty-sixth Congress, first session, contains a very detailed description of this section, with plans and estimates for its improvement.

The Muscle Shoals and Colbert Shoals have been the scene of more or less active operations since 1830, and have been the subject of so many reports and projects that abundant information concerning these obstructions is of record.

The lower section has been described in general terms in the Annual Reports of the Chief of Engineers, and between 1895 and 1897 was completely surveyed and mapped. The improvement of this section by means of extensive dredging operations at the shoals and bars is now under way.

Drainage area.—The total area drained by the Tennessee River, as determined by planimeter measurements of the topographic charts of the United States Geological Survey and other official maps and records, is 40,812 square miles. Of this total 21,410 square miles lie above Chattanooga, Tenn., and 5,500 square miles lie between Chattanooga and Lock A. The accompanying map of Tennessee Basin, plate No. 2, shows the form of the basin and distribution to the principal tributaries. This is also given in the following table, which shows the names of the principal tributaries, the distance to the mouth of each above Paducah, as well as the areas drained.

TABLE No. 2.—*Area and distribution of the drainage basin of the Tennessee River.*

Designation.	Distance above Paducah to outlet.	Area.	Remarks.
	Miles.	*Sq. miles.*	
French Broad River Basin	651.35	5,100.3	Geological Survey charts.
Holston River Basin	651.35	3,810.6	Do.
Little River Basin	634.35	375.9	Do.
Little Tennessee River Basin	600.60	2,649.5	Do.
Clinch River Basin	567.10	4,405.4	Do.
Hiwassee River Basin	498.30	2,705.6	Do.
Miscellaneous above Chattanooga	....	2,362.9	Do.
Total area above Chattanooga	463.35	21,410.2	Do.
Sequatchie River Basin	421.85	592.9	Do.
Miscellaneous between Chattanooga and Lock A, Muscle Shoals Canal	....	4,900	Do.
Total above Lock A	285.6	26,903.1	Do.
Elk River Basin	285.3	2,400	Postal maps.
Miscellaneous between Lock A and Riverton	....	2,384.9	Do.
Total above Riverton	226	31,688	
Duck River Basin	100	3,625	Do.
Miscellaneous between Riverton and Paducah	....	5,498.6	Do.
Total above Padncah	....	40,811.6	

The map and table show clearly that practically all of the large tributaries enter the river above Chattanooga, and that in consequence the increase in the flow below Chattanooga will be gradual, and is due to numerous small streams emptying directly into the river.

The distribution of the drainage area, by States, is approximately as follows:

	Sq. miles.
Tennessee	21,963.6
Alabama	6,835
North Carolina	5,220
Virginia	3,393
Georgia	1,800
Kentucky	1,050
Mississippi	550
Total	40,811.6

Generally speaking, the upper part of the basin is rough, mountainous, and practically undeveloped, except along the lines of communication. Below Bridgeport the valley widens out on the north side of the river, and the country is well settled and developed for agricultural purposes. The valley of the lower section of the river is comparatively flat and unusually rich and productive. Immense deposits of coal, iron ore, slate, marble, and other useful minerals, and almost boundless forests of virgin timber exist throughout the upper basin, and await development and better transportation facilities.

Rainfall.—Through the kindness of the local officials of the United States Weather Bureau, the precipitation records for a number of stations throughout the basin have been placed at my disposal. These records were not as a general thing complete, covering only the winter or wet months in many instances. It has, however, been possible, by carefully adjusting all of the observations, to deduce first the mean monthly, and from these, by summation, the mean annual rainfall at each of the stations. A tabulation of these results is given below, arranged progressively, to show the precipitation over the tributary basins, as well as in the main basin of the river.

TABLE No. 3.—*Mean precipitation in Tennessee River Basin.*

Locality.	Period covered by observation, years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
French Broad River Basin.														
Greenville, Tenn	2	3.73	3.70	8.00	2.98	3.50	2.59	3.17	3.63	3.25	2.32	2.01	2.90	41.78
Asheville, N. C	12	3.08	3.65	3.81	2.66	3.99	3.88	4.68	3.87	4.06	2.31	2.80	2.47	41.26
Holston River Basin.														
Bluff City, Tenn	4	2.35	4.38	5.73	2.44	3.61	4.75	4.37	2.89	3.20	2.24	1.79	2.15	39.90
Abingdon, Va	8	3.60	4.58	3.25	3.00	4.25	3.62	5.17	3.98	2.57	2.80	2.28	3.02	42.12
Rogersville, Tenn	13	3.78	4.81	5.18	3.25	3.97	3.94	5.25	3.62	2.27	2.53	2.65	2.93	42.68
Strawberry Plains, Tenn	6	3.89	4.78	4.47	3.67	3.25	4.27	3.92	3.94	2.91	1.28	3.35	2.63	42.36
Clinch River Basin.														
Spears Ferry, Va	3	3.64	5.40	7.94	3.22	4.81	4.74	7.56	4.71	2.78	2.28	2.21	3.05	52.34
Clinton, Tenn	11	5.42	6.03	5.90	4.46	3.56	4.66	6.13	3.68	2.85	2.45	3.09	3.75	51.96
Tazewell, Tenn	4	4.47	5.18	5.16	2.97	4.22	4.74	3.89	2.39	3.23	3.65	3.94	3.53	47.39
Kingston, Tenn	8	5.38	5.79	5.33	4.48	3.44	3.95	4.78	3.80	4.26	2.60	3.38	3.28	50.47
Little Tennessee River Basin.														
Bryson, N. C	13	4.61	5.69	6.11	3.68	4.01	3.89	5.47	5.25	3.44	2.79	3.26	3.55	51.75
Hiwassee River Basin.														
Murphy, N. C	13	4.65	6.28	6.34	4.17	3.82	5.07	6.75	4.99	3.83	2.70	4.22	3.87	56.69
Charleston, Tenn	6	5.25	5.48	6.05	4.87	4.62	6.36	5.02	3.51	4.69	1.92	3.54	3.74	55.05
Tennessee River Basin.														
Knoxville, Tenn	22	5.55	4.80	5.43	4.13	4.04	3.87	4.51	3.71	2.51	2.64	3.27	3.56	48.05
Loudon, Tenn	9	5.34	5.83	5.52	5.17	4.12	4.16	5.02	3.43	3.36	1.74	3.51	3.62	50.82
Rockwood, Tenn	9	1.70	5.69	6.30	5.15	4.67	3.77	4.08	4.87	2.36	4.03	3.25	3.65	49.52
Chattanooga, Tenn	22	6.04	5.38	6.29	4.73	3.68	4.47	4.00	3.66	3.50	2.84	3.75	4.40	52.74
Bridgeport, Ala	4	5.40	4.77	8.74	5.16	2.95	3.45	3.92	2.21	2.75	3.53	5.43	5.48	43.79
Nashville, Tenn.[1]	28	5.05	5.01	5.37	4.70	3.46	4.15	4.58	3.42	3.91	2.39	3.85	3.66	49.55
Fayetteville, Tenn	10	4.72	5.37	4.88	4.71	3.86	3.97	4.74	2.64	2.64	2.36	2.52	3.61	46.23
Scottsboro, Ala	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	52.95
Madison, Ala	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	45.68
Decatur, Ala	16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	48.62
Florence, Ala	9	4.86	4.77	5.80	5.79	3.19	4.09	5.10	4.01	2.35	1.73	3.24	4.71	49.67
Riverton, Ala	3	5.50	4.60	5.01	2.58	3.64	3.46	2.60	1.31	4.66	4.87	6.90	.....	50.23
Savannah, Tenn	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	44.00
Johnsonville, Tenn	6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	41.05
Paducah, Ky	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	45.38
Adjusted mean of all observations above Chattanooga[2]	.....	4.32	5.23	5.64	3.98	3.32	4.37	4.85	3.98	3.24	2.59	3.21	3.46	48.39

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[1] Not in basin.

[2] This mean is adjusted with reference to the time covered by the observations.

It is not possible from the analysis of observations covering such short periods of time to reach a definite or satisfactory conclusion as to the mean precipitation in the basin. The observations at Knoxville, Chattanooga, and Nashville, covering a period of more than twenty-two years, afford the best evidence; but, according to Mr. Alfred J. Henry, chief of division, United States Weather Bureau, it is necessary to consider continuous observations covering at least thirty-five or forty years in order to obtain mean results that will not depart more than 5 per cent from the true normal. However, in the absence of more and better data, it is necessary to use that at hand. From this it appears that the normal rainfall above Chattanooga is about 49 inches per year, while for the whole basin it is probably about 48 inches.

The maximum monthly precipitation recorded for the upper basin is 16.98 inches at Knoxville in January, 1882. This was exceeded at Newburg, Ala., in March, 1897, when a fall of 20.83 was recorded. The mean for March, 1897, over North Alabama, was 15.44 inches. The maximum annual precipitation recorded is 66.36 at Knoxville in 1882, and 67.25 inches at Bryson City, N. C., in 1891. The maximum for North Alabama was 68.64 inches at Scottsboro in 1895.

The minimum annual rainfall is about 36 inches, and varies as follows:

	Inches.
Asheville, N. C., in 1894	34.01
Johnsonville, Tenn., in 1894	35.77
Paducah, Ky., in 1895	36.39
Rogersville, Tenn., in 1895	36.44
Chattanooga, Tenn., in 1894	37.22
Knoxville, Tenn., in 1894	37.44

Bulletin D, of the United States Weather Bureau, 1897, gives some interesting and valuable information concerning the rainfall in the United States. From one of the charts in this publication it is seen that a large part of the Tennessee Basin is included in the area over which the mean rainfall is over 50 inches, and for part of it reaches 60 inches per annum. Except along the coast, this represents the region of maximum rainfall in the United States, and makes clear why the flow of the Tennessee is greater than that of many rivers of the same or larger drainage. The mean annual rainfall over the Upper Ohio Valley is 41.3 inches, and over the Middle Mississippi Valley is 35.3 inches, showing an advantage in this respect of from 25 to 40 per cent in favor of the Upper Tennessee.

Stages of the river.—The daily fluctuations of the elevation of the water surface of the river have been systematically observed at a number of stations for several years. The first effort in this direction of which we have a record was inaugurated at Florence, Ala., in 1871. The gauge then established has been regularly read ever since. This was followed, in 1874, by the establishment of gauges at Knoxville, Kingston, Loudon, Chattanooga, Decatur, Johnsonville, and Paducah, in connection with the investigation being made by Maj. Walter McFarland, Corps of Engineers, of a "Southern route to the seaboard." All of these gauges, except Loudon, have been read regularly since their establishment, either by the Weather Bureau or the Engineer Department.

In addition to the gauges above enumerated, the following have been read regularly: At Miltons Bluff since 1879; at Charleston, Tenn., on the Hiwassee River, during winter months, since 1884; at Clinton, Tenn., Spears Ferry, on the Clinch River, and Strawberry Plains, on the Holston River, during the winter months, since 1884; at both divisions of the Muscle Shoals Canal since 1890; at Riverton, Ala., and at the head of Colbert Shoals since 1891. These observations, together with those of a number of special gauges, have all been platted on hydrograph sheets, and form part of the permanent records of this office.

The following table has been prepared to show the location, elevation, and range of stage at each of the important gauges on the river:

TABLE No. 4.—*Gauge data of the Tennessee River and principal tributaries.*

Location of principal gauges.	River.	Period covered by observation.	Elevation of zero above sea level.	Extreme low water.		High water.		Extreme range.
				Corresponding gauge reading.	Date.	Corresponding gauge reading.	Date.	
			Feet.					*Feet.*
Strawberry Plains[1]	Holston	Feb., 1885, to date.	836.4	−1.5	Dec., 1895	34.0	Mar., 1867	35.5
Knoxville[1]	Tennessee	Jan., 1875, to date.	[2]773.76	−1.5	do	39.0	Mar., 1875	40.5
Spears Ferry[1]	Clinch	Dec., 1895, to date.	120.9	−1.4	Jan., 1896	23.2	Apr., 1896	24.2
Clinton[1]	do	Dec., 1884, to date.	773.95	0.0	Dec., 1883	45.0	Mar., 1886	45
Kingston[1]	Tennessee	Dec., 1874, to date.	699.96	−0.9	Dec., 1894	42.5	Mar., 1867	43.4
Charleston[1]	Hiwassee	Dec., 1884, to date.	667.20	−0.1	do	32.2	Mar., 1886	32.3
Chattanooga	Tennessee	Apr., 1874, to date.	617.81	0.0	Sept., 1883	58.6	Mar., 1867	58.6
Bridgeport[1]	do	Mar., 1892, to date.	582.00	−0.2	Oct., 1897	41.0	do	41.2
Guntersville	do	Aug., 1895, to Dec., 1896.	544.87	0.0		46.16	do	46.16
Decatur	do	Oct., 1875, to date.	529.99	−0.8	Oct., 1884	28.5	do	29.3
Milton Bluff[1]	do	Jan., 1879, to date.	522.95	0.0	Oct., 1894	12.7	Mar., 1897	12.7
Florence	do	Nov., 1871, to date.	396.77	−0.8	Oct., 1872	32.5	do	33.3
Riverton	do	May, 1891, to date.	359.56	−2.2	Oct., 1897	50.3	do	52.5
Johnsonville	do	Oct., 1875, to date.	315.6	−0.3	do	48.0	do	48.3
Paducah	do	June, 1874, to date.	279.2	−0.7	Oct., 1895	54.2	Feb., 1884	54.9

[1] Records not complete.

[2] Gay street gauge.

A study of the hydrographs shows that the river is rarely, if ever, entirely obstructed by ice, and that periods of extreme high water are rare. The greatest range between high and low water is 70 feet at the "Suck" in the mountain section below Chattanooga. The least range is at the Muscle Shoals, where it amounts to 12.7 feet.

In order to illustrate the daily fluctuations over the middle and adjacent sections, the hydrographs for Chattanooga, Decatur, and Riverton, Ala., for 1895 to 1899, inclusive, are reproduced herewith as plate No. 3, and are shaded in such a manner as to indicate by the depth of shade the relative time the river has been at or above a given stage.

The record of the gauge at Chattanooga from 1879 to 1900, inclusive, has been selected for special study in connection with the improvement of the middle section of the river, it being assumed that this gauge, although not directly in the middle section, is sufficiently close and representative to be made the gauge of reference.

The mean conditions at Chattanoooga are well represented by Table No. 5, which shows the mean monthly stage for each month from 1879 to 1900, inclusive; also the mean annual stage for each year and the means for the whole period.

Table No. 5.—*Mean monthly and annual stages of the Tennessee River at Chattanooga, Tenn., 1879–1900.*

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Mean.
1879	14.4	10.8	6.4	6.8	4.5	2.2	1.1	2.8	1.3	3.0	2.6	11.0	5.6
1880	6.5	9.2	19.6	10.8	7.0	3.6	3.6	3.3	2.5	1.5	3.1	10.1	6.7
1881	9.7	12.1	9.2	10.0	5.3	3.5	2.1	1.0	2.1	1.2	6.3	10.4	6.1
1882	26.6	19.2	13.5	8.1	5.9	6.4	4.7	4.2	6.7	2.4	2.4	4.4	8.7
1883	15.0	10.7	6.8	18.4	5.9	4.5	2.7	1.7	0.9	2.0	3.7	5.1	6.5
1884	8.6	22.6	24.1	10.9	6.5	5.9	4.9	3.4	1.3	0.5	1.0	4.2	7.8
1885	11.2	7.1	3.5	6.3	5.4	3.0	3.7	2.7	1.5	4.5	10.7	8.8	5.7
1886	12.7	8.1	9.9	20.9	8.3	10.2	8.2	5.0	2.7	1.6	4.9	8.1	8.4
1887	9.4	15.4	10.7	7.5	5.4	6.5	3.3	4.9	2.0	2.3	1.9	3.0	6.0
1888	11.4	7.9	8.8	10.0	5.6	4.9	3.4	3.0	7.4	6.6	10.8	5.0	7.1
1889	9.7	13.7	6.3	5.1	3.6	7.0	5.5	6.3	5.1	2.7	7.9	4.7	6.5
1890	6.8	11.9	21.0	10.7	4.9	4.3	3.8	4.7	4.1	6.0	3.7	5.5	7.3
1891	9.7	22.4	19.1	10.1	4.6	5.7	3.7	6.3	3.6	1.6	2.8	6.2	8.0
1892	14.7	7.4	7.3	15.1	6.3	6.9	7.1	3.5	2.5	1.4	3.9	5.0	6.8
1893	4.2	14.4	8.2	6.7	11.2	8.0	3.6	3.0	5.1	3.5	2.8	3.4	6.2
1894	5.9	11.7	7.6	5.7	4.7	6.0	3.3	3.0	1.8	1.2	1.1	4.2	4.7
1895	11.5	5.8	11.9	8.3	7.5	3.8	4.3	3.9	2.2	0.8	1.5	2.4	5.3
1896	4.1	9.0	6.3	11.3	3.1	3.8	9.1	3.5	1.8	1.6	3.5	5.3	5.2
1897	4.4	13.3	22.0	12.4	8.3	4.6	5.5	3.5	1.2	1.0	0.9	3.8	6.7
1898	9.1	4.2	4.3	9.4	4.3	2.9	3.6	8.1	7.6	7.2	5.0	5.1	5.9
1899	8.1	16.2	23.5	11.9	7.2	4.4	2.8	2.1	1.7	1.1	1.2	4.0	7.0
1900	5.7	9.0	11.3	8.2	4.0	6.0	4.8	2.7	2.4	2.5	4.5	5.3	5.5
Mean	10.0	11.9	11.9	10.2	5.9	5.2	4.3	3.8	3.1	2.6	3.9	5.7	6.5

From the same source the mean daily stage for twenty-two years has been determined and tabulated.

Table No. 6.—*Mean daily stage Tennessee River at Chattanooga, Tenn., 1879–1900.*

Day of month.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	5.7	9.0	11.6	12.3	7.0	5.9	4.5	4.3	3.4	2.6	3.4	4.9
2	6.1	9.5	11.3	13.2	6.7	6.0	4.4	4.5	3.3	2.7	3.3	5.5
3	6.5	9.5	11.0	13.2	6.5	7.0	4.3	4.6	3.4	2.6	3.1	4.8
4	6.8	9.8	10.7	13.0	6.8	5.8	4.4	4.6	3.6	2.4	3.1	4.7
5	6.7	11.2	10.3	13.0	6.7	5.5	4.7	4.6	3.9	2.4	2.8	4.4
6	6.8	11.5	10.7	12.7	7.1	5.4	4.7	4.7	3.8	2.7	2.8	4.4
7	6.9	11.5	11.3	12.4	7.5	5.7	4.8	4.8	3.5	2.6	3.0	4.8
8	7.1	11.8	12.1	12.3	7.2	5.8	4.9	4.6	3.1	2.4	3.6	4.6
9	8.1	12.5	12.9	11.8	6.7	5.7	4.7	4.3	3.0	2.4	3.9	4.7
10	10.0	13.6	13.4	11.3	6.3	5.7	4.9	4.1	2.8	2.3	4.5	4.7
11	10.0	14.0	13.6	11.0	6.3	5.4	5.0	4.0	2.6	2.2	4.8	4.7
12	10.5	13.8	13.0	10.5	6.1	5.3	4.9	3.8	3.0	2.2	4.6	5.0
13	11.8	13.7	12.5	9.7	5.9	5.3	4.5	3.8	3.6	2.2	4.4	5.4
14	12.9	14.7	11.8	9.4	6.3	5.2	4.1	3.8	3.8	2.1	4.3	5.6
15	12.4	14.0	12.0	9.1	6.3	5.1	4.0	3.8	3.6	2.2	4.2	6.2
16	12.8	13.5	12.5	8.7	6.1	5.0	4.0	3.7	3.0	2.1	3.9	6.5
17	13.1	13.2	12.5	8.8	5.8	4.9	4.1	3.6	3.0	2.3	3.7	6.5
18	13.1	13.1	12.5	8.4	5.4	4.8	4.3	3.4	3.2	2.1	3.7	6.1
19	12.3	12.6	12.4	8.9	5.3	5.1	4.2	3.4	3.3	2.3	3.9	5.4
20	12.5	12.1	12.6	9.2	5.3	5.0	4.0	3.2	3.0	2.6	3.9	5.0
21	12.8	12.1	13.0	9.2	5.3	5.0	3.8	3.1	3.1	2.6	3.7	5.5
22	12.9	11.8	13.4	8.6	5.5	4.9	3.6	3.1	2.8	2.5	3.4	6.3
23	12.4	11.1	13.6	8.4	5.4	4.9	3.6	3.1	2.6	2.4	3.6	6.6
24	12.5	11.1	12.9	9.3	5.5	4.7	3.6	3.2	2.5	2.4	4.1	6.9
25	12.5	11.3	11.3	9.3	5.5	4.7	3.8	3.1	2.6	2.7	4.4	6.8
26	11.2	11.7	10.4	9.3	5.7	4.6	3.8	3.2	2.7	3.0	4.5	6.8
27	9.9	11.7	10.2	9.2	5.5	4.3	3.5	3.2	2.5	3.2	4.6	7.0
28	9.0	11.9	10.1	8.3	5.5	4.5	4.7	3.2	2.4	3.4	4.5	7.0
29	8.5	7.5	10.1	7.5	5.4	4.7	4.6	3.2	2.3	3.2	4.5	6.8
30	8.6	......	10.9	7.2	5.3	4.6	4.9	3.1	2.4	3.2	4.9	6.0
31	8.6	......	11.2	......	5.4	......	3.8	3.1	......	3.3	......	5.9
Mean	10.0	11.9	11.9	10.2	5.9	5.2	4.3	3.8	3.1	2.6	3.9	5.7

The approximate discharge corresponding to the mean monthly and annual stages given by Table No. 5 has been platted on plate No. 4, figures 2 and 3, in comparison with the mean monthly and annual rainfall at Chattanooga and Knoxville for the same period, taken from Table No. 3. So, also, the figures given in Table No. 6 have been platted on plate No. 4, figure 1, in comparison with the actual daily gauge readings for 1882, when the mean stage was a maximum, and for 1894, when the mean stage was a minimum.

A review of these two tables shows the annual mean to vary from 4.7 feet in 1894 to 8.7 feet in 1882; the monthly mean to vary from 0.5 foot in October, 1884, to 26.6 feet in January, 1882, and the daily mean to vary from 14.7 feet for February 14 to 2.1 feet for October 16. The mean annual stage is shown to be 6.5 feet, from which it is seen by comparison with the daily, monthly, and annual means that the river is essentially a low-water stream, and that for eight months in the year its normal condition is below the mean.

The following table has been prepared from the daily records at Chattanooga since 1875 to show directly the exact number of days each year, the total number of days in the 26 years considered, and the mean number of days per year the river has been above given stages. The uses of this table are manifold; for instance, 3 feet by the Chattanooga gauge is said by steamboat men to be the lowest stage at which active and profitable navigation can now be carried on. The table shows that during the past 26 years the river has been above this stage 73.8 per cent of the time, or an average of 270 days per annum. In 1894 the period was only 210 days, or 58 per cent of the year, while in 1888 it was 335 days, or 92 per cent of the year. Similarly the table can be used to study the probable effect of floods. A 30-foot stage, which corresponds to the general overflow of the banks, has been exceeded for 146 days, or 1.5 per cent of the whole time considered; floods attaining a height of 45 feet or more have lasted but three-tenths of one per cent, and floods of 50 feet or more but one-tenth of one per cent of the time considered.

TABLE No. 7.—*Stages of Tennessee River at Chattanooga, Tenn., 1875–1900.*

Year.	Number of days each year that river has been above the stages given.											
	Stage by Chattanooga gauge.											
	0.0.	0.5.	1.0.	2.0.	3.0.	4.0.	5.0.	10.0.	20.0.	30.0.	40.0.	50.0.
1875	365	365	365	365	330	288	245	91	37	22	9	4
1876	366	366	366	308	246	220	200	105	7	1	......	......
1877	365	365	365	318	256	172	140	56	13	......	......	......
1878	365	365	363	307	235	197	169	55	......	......	......	......
1879	365	350	338	270	214	180	147	53	11	5	......	......
1880	366	366	366	320	259	209	177	60	19	6	......	......
1881	365	343	311	279	249	185	178	62	3	......	......	......
1882	365	365	365	349	296	256	211	83	39	14	1	......
1883	365	350	341	270	238	190	159	71	15	7	......	......
1884	366	349	308	263	244	218	183	93	37	15	4	......
1885	365	365	363	330	299	249	191	37	9	......	......	......
1886	365	365	365	328	296	283	254	96	17	12	7	2
1887	365	365	365	308	269	209	159	56	14	......	......	......
1888	366	366	366	362	335	291	224	60	12	......	......	......
1889	365	365	365	365	330	274	199	46	6	......	......	......
1890	365	365	365	365	334	255	145	64	15	6	3	......
1891	365	365	365	321	298	240	195	88	27	10	......	......
1892	366	366	366	327	294	249	222	43	12	8	......	......
1893	365	365	365	359	275	205	167	46	16	4	......	......
1894	365	365	333	269	210	154	122	15	3	......	......	......
1895	365	365	340	277	240	185	150	36	7	3	......	......
1896	366	366	366	314	243	156	105	44	8	4	1	......
1897	365	359	315	271	237	196	157	65	29	15	......	......
1898	365	365	365	359	315	248	167	44	2	......	......	......
1899	365	365	351	252	215	190	155	68	26	14	1	......
1900	365	365	365	330	256	200	163	37	3	......	......	......
Total	9,496	9,421	9,209	8,186	7,013	5,699	4,584	1,577	377	146	26	6
Mean	365.2	362.3	354.1	314.5	269.7	251.3	176.3	60.7	14.5	5.6	0.9	0.3
Per cent	100	99.2	97.0	86.2	73.8	59.8	48.3	16.6	3.9	1.5	0.3	0.1

Discharge.—The correct determination of the discharge, particularly at low water, is one of the essential features of a study of the low-water improvement of a river; consequently a special effort has been made to accumulate and discuss all available data of this kind. For convenience of reference and study, all of the reliable gaugings of the river obtainable have been arranged and tabulated below, and also platted on plate No. 5. These consist of two observations made at Knoxville, two at Huffs Ferry, and one at Soddy Shoals in 1891-92 by Captain Biddle in connection with the survey of the upper river; of three observations made at Chattanooga and one at Tumbling Shoals in 1891 by Mr. D. L. Sublett, assistant engineer; of one observa-

tion made in 1894 by Mr. George W. Brown, assistant engineer, and fifty-five observations made in 1899 by Mr. W. S. Winn, assistant engineer, at Riverton, Ala.; of one observation made in 1894 by Mr. George W. Brown, assistant engineer, and one made by Mr. W. G. Price, assistant engineer, in 1895, at Livingston Point, Ky.; of twelve observations made at Chattanooga in 1891 by the United States Weather Bureau, and of seven observations made at Knoxville and of twenty-two observations made at Chattanooga, 1897–1900, by the United States Geological Survey. These latter observations form a valuable addition to our knowledge of the flow of the Upper Tennessee, and without them it would have doubtless been necessary for the present investigation to have undertaken a special series of low-water gaugings.

The discharge of the principal tributaries above Chattanooga has been discussed in my previous reports to you on the improvement of these streams.

TABLE No. 8.—*Discharge of Tennessee River.*

[Observations 1 and 2 are referred to Gay street gauge; 3 to 7 are referred to new gauge; 10 is referred to Loudon gauge; 12 is referred to gauge at Chattanooga, 22 miles below Soddy Shoals; 50 is referred to gauge at Chattanooga, 9 miles above Tumbling Shoals; 107–110 are referred to Paducah gauge.]

No.	Place of observation.	Date.	Gauge.	Discharge per second.	Condition.	Remarks.
				Cubic feet.		
1	Knexville, Tenn ...	May 28, 1891	2.5	11,150	Rising......	Captain Biddle and Assistant Van Ornum.
2	.....do..............	Oct. 17, 1891	0.8	3,950	Stationary..	Do.
3	.....do..............	Nov. 17, 1897	0.5	3,084	Slow rise ...	United States Geological Survey.
4	.....do..............	May 4, 1899	1.9	12,810	Slow fall ...	Do.
5	.....do..............	May 25, 1899	1.7	10,131	Stationary..	Do.
6	.....do..............	Sept. 16, 1899	0.1	3,912	Slow fall ...	Do.
7	.....do..............	Oct. 26, 1899	−0.6	2,728	Stationary..	Captain Biddle and Assistant Van Ornum.
8	.....do..............	Apr. 25, 1900	4.35	17,219	Falling.....	United States Geological Survey.
9	.....do..............	Dec. 7, 1900	5.50	23,529	.....do......	Do.
10	Huffs Ferry	Aug. 1, 1891	5.0	25,350	Rising......	Captain Biddle and Assistant Van Ornum.
11	.....do..............	Oct. 23, 1891	0.9	6,850	Stationary..	Do
12	Soddy Shoals.......	Dec. 12, 1892	2.3	13,700	Rising......	Do
13	Chattanooga, Tenn.	Nov. 13, 1891	3.0	17,560	.....do......	Assistant Engineer D. L. Sublett.
14	.....do..............	Apr. 11, 1892	30.0	195,000	Falling.....	Do
15	.....do..............	Jan. 15, 1891	35.0	240,000	Rising......	Do
16	.....do..............	Mar. 15, 1893	10.3	58,000	Slow fall ...	These observations (Nos. 16 to 24) were made by L. M. Pindell, observer, United States Signal Service. The results given were recalculated by G. T. Nelles in 1899, using a coefficient of 0.95, deduced from Tennessee River observation to reduce the observed mid-depth velocity to mean velocity.
17	.....do..............	Mar. 16, 1893	9.2	53,030	.....do......	
18	.....do..............	Apr. 3, 1893	5.1	27,420	Stationary..	
19	.....do..............	Apr. 4, 1893	5.1	27,369	.....do......	
20	.....do..............	May 5, 1893	26.0	158,760	Rising......	
21	.....do..............	May 8, 1893	25.9	151,830	Rapid fall ..	
22	.....do..............	May 9, 1893	15.8	91,855	.....do......	
23	.....do..............	May 17, 1893	9.9	58,780	Slow rise ...	
24	.....do..............	May 18, 1893	10.4	61,132	.....do......	
25	.....do..............	....	8.0	45,480	....	Nos. 25–27, from Part IV, Daily River Stages, United States Weather Bureau, 1893; recalculated by G. T. Nelles, 1899.
26	.....do..............	....	2.0	12,880	....	
27	.....do..............	....	30.0	227,180	....	
28	.....do..............	May 8, 1897	7.07	44,187	Slow fall ...	Nos. 28–49, United States Geological Survey. In all United States Geological Survey observations the velocity observed at $\frac{6}{10}$ the depth was assumed to be the mean velocity at point of observation.
29	.....do..............	May 28, 1897	4.52	25,892	.....do......	
30	.....do..............	June 29, 1897	5.76	32,943	.....do......	
31	.....do..............	July 13, 1897	4.59	26,884	Crest	
32	.....do..............	Sept. 7, 1897	1.67	10,313	Stationary..	
33	.....do..............	Oct. 6, 1897	0.48	5,969	.....do......	
34	.....do..............	Nov. 16, 1897	0.83	5,552	.....do......	
35	.....do..............	Dec. 23, 1897	10.30	67,000	Crest	
36	.....do..............	May 10, 1898	4.14	22,066	Slow rise ...	
37	.....do..............	July 29, 1898	5.30	29,693	.....do......	
38	.....do..............	Aug. 19, 1898	6.37	36,671	Slow fall ...	
39	.....do..............	Oct. 6, 1898	17.60	120,359	Crest	
40	.....do..............	Oct. 28; 1898	6.00	35,953	Slow fall ...	
41	.....do..............	Nov. 29, 1898	4.75	29,569	Stationary..	
42	.....do..............	.....do.......	4.70	31,340	.....do......	
43	.....do..............	May 3, 1899	6.71	37,770	Slow fall....	
44	.....do..............	May 26, 1899	4.76	25,526	.....do......	
45	.....do..............	June 21, 1899	4.15	21,391	.....do......	
46	.....do..............	Sept. 15, 1899	1.90	10,819	.....do......	
47	.....do..............	Oct. 27, 1899	0.80	6,566	Stationary..	
48	.....do..............	Mar. 13, 1900	11.25	66,012	Rapid fall ..	
49	.....do..............	July 27, 1900	3.45	18,470	Slow rise ...	

TABLE No. 8.—*Discharge of Tennessee River*—Continued.

No.	Place of observation.	Date.	Gauge.	Discharge per second.	Condition.	Remarks.
				Cubic feet.		
50	Tumbling Shoals	Nov. 5, 1891	1.20	8,200	Stationary	Assistant Engineer D. L. Sublett.
51	Riverton, Ala	Oct. 8, 1894	−1.0	10,250	.....do	Assistant Engineer G. W. Brown.
52	.....do	Jan. 10, 1899	22.2	165,925	.....do	Nos. 52-106 by G. T. Nelles and W. S. Winn, assistant engineers.
53	.....do	Jan. 11, 1899	22.05	164,780	Rising	See annual report, 1899.
54	.....do	.....do	21.85	161,350	Slow fall	Do.
55	.....do	Jan. 12, 1899	21.10	156,180	.....do	Do.
56	.....do	.....do	20.85	153,595	.....do	Do.
57	.....do	Jan. 13, 1899	18.65	133,545	.....do	Do.
58	.....do	.....do	18.00	123,880	Falling	Do.
59	.....do	Jan. 14, 1899	14.75	100,555	Rapid fall	Do.
60	.....do	Jan. 16, 1899	10.75	75,880	.....do	Do.
61	.....do	Jan. 16, 1899	10.40	71,065	Falling	Do.
62	.....do	Jan. 17, 1899	9.50	67,345	.....do	Do.
63	.....do	.....do	9.35	64,335	Slow fall	Do.
64	.....do	Jan. 18, 1899	8.85	61,450	.....do	Do.
65	.....do	Jan. 19, 1899	8.35	61,080	.....do	Do.
66	.....do	Jan. 20, 1899	7.95	57,445	.....do	Do.
67	.....do	.....do	7.90	55,855	Stationary	Do.
68	.....do	Jan. 23, 1899	6.75	51,905	Slow fall	Do.
69	.....do	Feb. 6, 1899	23.50	194,450	Rising	Do.
70	.....do	Feb. 8, 1899	28.25	236,960	.....do	2,000 cubic foot-seconds.[1]
71	.....do	.....do	28.45	237,140	.....do	2,500 cubic foot-seconds.[1]
72	.....do	Feb. 9, 1899	29.15	246,055	Slow rise	3,000 cubic foot-seconds.[1]
73	.....do	Feb. 10, 1899	29.80	254,420	.....do	4,000 cubic foot-seconds.[1]
74	.....do	Feb. 11, 1899	30.70	264,180	Rising	5,000 cubic foot-seconds.[1]
75	.....do	Feb. 13, 1899	32.30	277,350	.....do	7,000 cubic foot-seconds.[1]
76	.....do	Feb. 14, 1899	32.75	274,355	Slow rise	8,000 cubic foot-seconds.[1]
77	.....do	Feb. 15, 1899	32.20	255,000	Falling	6,000 cubic foot-seconds.[1]
78	.....do	Feb. 16, 1899	29.00	187,235	.....do	2,000 cubic foot-seconds.[1]
79	.....do	Feb. 17, 1899	23.05	128,010	.....do	See annual report, 1899.
80	.....do	Feb. 20, 1899	13.00	90,510	Stationary	Do.
81	.....do	Feb. 27, 1899	20.70	167,680	Rapid rise	Do.
82	.....do	Feb. 28, 1899	23.05	180,505	.....do	Do.
83	.....do	Mar. 1, 1899	24.0	189,815	Falling	Do.
84	.....do	Mar. 2, 1899	23.55	174,240	.....do	Do.
85	.....do	Mar. 3, 1899	23.10	171,360	.....do	Do.
86	.....do	Mar. 4, 1899	22.30	164,995	.....do	Do.
87	.....do	Mar. 14, 1899	18.0	130,505	Rising	Do.
88	.....do	Mar. 15, 1899	23.90	197,870	Rapid rise	Do.
89	.....do	Mar. 16, 1899	31.85	261,515	.....do	Do.
90	.....do	Mar. 17, 1899	34.35	300,620	.....do	Do.
91	.....do	Mar. 18, 1899	35.85	316,900	.....do	Do.
92	.....do	Mar. 19, 1899	38.05	348,035	.....do	Do.
93	.....do	Mar. 20, 1899	39.60	368,430	.....do	Do.
94	.....do	Mar. 21, 1899	40.00	372,120	Crest	Do.
95	.....do	Mar. 22, 1899	40.00	360,125	.....do	Do.
96	.....do	Mar. 23, 1899	39.50	338,025	Falling	Do.
97	.....do	Mar. 24, 1899	39.05	333,485	.....do	Do.
98	.....do	Mar. 25, 1899	38.70	318,055	.....do	Do.
99	.....do	Mar. 27, 1899	38.20	325,160	.....do	Do.
100	.....do	Mar. 29, 1899	36.40	277,185	.....do	Do.
101	.....do	.....do	36.40	282,650	.....do	Do.
102	.....do	Mar. 30, 1899	34.20	222,705	.....do	Do.
103	.....do	Mar. 31, 1899	31.00	177,040	.....do	Do.
104	.....do	Apr. 1, 1899	28.60	170,595	.....do	Do.
105	.....do	.....do	28.20	168,000	.....do	Do.
106	.....do	Apr. 3, 1899	26.20	168,570	.....do	Do.
107	Livingston Point, Ky.	Oct. 19, 1894	0.40	10,150	Stationary	G. W. Brown, assistant engineer.
108	.....do	Nov. 6, 1895	−0.57	10,601	.....do	W. G. Price, assistant engineer.
109	Ohio River	.....do	−0.57	10,041	.....do	W. G. Price, above Tennessee River.
110	.....do	Nov. 5, 1895	−0.61	21,262	.....do	W. G. Price, below Tennessee River.

[1] Estimated overflow added to observed results.

No discharge observations have been made directly in the middle section of the river. It is thought, however, that the complete determination at Chattanooga, 20 miles above the upper end, and at Riverton, 60 miles below the lower end of the section, will afford an ample and satisfactory basis of determining the flow at intermediate points, either from a consideration of the areas drained or of the distances from the points named.

Through an analysis by means of the method of least squares of all the observations at Chattanooga, except Nos. 27, 34, 35, and 39, which for various reasons appear to be inconsistent, the following equation for the curve representing the mean discharge, in terms of the gauge height, has been deduced:

$$Q=3{,}700+4{,}700\ G+55\ G^2 \ldots\ldots\ldots\ldots (1)$$

Q representing the discharge in cubic feet per second and G the reading of the Chattanooga gauge in feet.

In the same manner, using all of the Riverton observations except Nos. 78, 79, 98, 100 to 106, which are to some extent inconsistent, assuming the extreme low-water discharge, which is not well determined by the observations, to be 6,000 cubic feet per second, and bearing in mind that extreme low water at this gauge corresponds to a reading of minus 2 feet, we obtain the following expression for the mean discharge at Riverton:

$$Q=6{,}000+4{,}225\ (G+2)+103\ (G+2)^2 \ldots\ldots\ldots\ldots (2)$$

An examination of the Riverton curve, plate No. 5, fig. 2, shows that only those observations made during rising stages are outside of the mean curve, and that the variations between the mean and observed maximum flow are in no case more than 10 per cent. During falling stages the variation between the mean and the observed flow is much greater and more irregular, amounting in some instances to fully 25 per cent.

By means of the first formula (1) the flow per second, corresponding to the mean monthly stage at Chattanooga, as given by the bottom line of Table No. 5, has been calculated, and is given in the following table, in comparison with mean quantity of rain in cubic feet per second falling on the basin drained, determined from the mean monthly precipitation above Chattanooga, given in Table No. 3. (See also pl. No. 4, figs. 2 and 3.)

TABLE No. 9.—*Mean run-off from basin of the Tennessee above Chattanooga, Tenn. (1879–1900).*

Month.	Mean monthly rainfall.	Corresponding quantity falling per second.	Mean monthly stage.	Corresponding run-off per second.	Run-off in terms of rainfall.
	Inches.	*Cubic feet.*	*Feet.*	*Cubic feet.*	*Per cent.*
January	4.52	83,940	10.0	56,200	67
February	5.23	106,550	11.9	67,420	63
March	5.64	104,740	11.9	67,420	64
April	3.98	76,380	10.2	57,360	75
May	3.32	61,650	5.9	33,350	54
June	4.37	83,940	5.2	30,850	30
July	4.85	90,060	4.3	24,930	26
August	3.98	73,990	3.8	22,350	30
September	3.24	62,000	3.1	18,800	30
October	2.59	48,100	2.6	16,290	34
November	3.21	61,600	3.9	22,870	48
December	3.46	64,250	5.7	32,280	50
Annual	48.39	76,311	6.5	36,570	48

The method adopted for calculating the run-off in cubic feet per second, corresponding to the mean monthly and annual stages, is only approximate, but probably gives results relatively as accurate as the data on which the calculations are based. The maximum discharge at Chattanooga for a gauge reading of 58.6 feet, obtained in March, 1867, is found by equation (1) to be 468,000 cubic feet per second, or nearly 125 times the minimum. The maximum discharge at Riverton for a gauge reading of 50.3 feet, obtained in March, 1897, is found by equation (2) to be 508,000 cubic feet per second, or about 85 times the minimum discharge.

The mean annual discharge of the Tennessee at Chattanooga, based on twenty-two years' observations, is found by equation (1) to be 36,570 cubic feet per second. The significance of this figure is made clearer by the comparison given below:

	Tennessee River at Chattanooga.	Ohio River at Paducah.[1]	Missouri River at its mouth.[1]	Mississippi River above Missouri River.[1]
Area of watershed .... square miles..	21,410	205,750	530,810	171,570
Mean discharge per second .... cubic feet..	36,570	307,000	100,000	130,000
Mean discharge per square mile .... do....	1.71	1.49	0.19	0.76

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[1] From page 2846, Annual Report of Chief of Engineers for 1898.

The minimum discharge at Chattanooga is probably 3,700 cubic feet per second, which corresponds to a flow of 0.17 cubic feet per second per square mile of watershed.

MIDDLE SECTION OF THE TENNESSEE RIVER.

General description.—What precedes, although it applies to the section under special consideration, is not always sufficiently in detail for the purposes of the present investigation.

At Kellys Ferry, 22 miles below Chattanooga, the bottom lands begin to widen out, and the character of the stream changes from almost torrential in the mountain section, and it becomes much more tranquil for all stages. To the foot of Bridgeport Island its course is sinuous and its bed is divided by several large islands. Below Bridgeport Island to Larkins Towhead its course is very nearly straight, following with but few and slight variations parallel to the range of high hills along its south bank. At Larkins Towhead, Gunters Mountain is encountered on the north bank. The straight course is continued, however, to Buck Island, where the river begins to curve sharply to the right, and then follows a crooked course, outlined by hills and mountains, to Honey Ferry, 8 miles below Guntersville. At Whitesburg, 24 miles below Guntersville, the mountains begin to disappear, and the valley becomes a rolling prairie. From Honey Ferry to the head of the upper division of the Muscle Shoals Canal the course of the river is again straight and uniform.

These long straight reaches, comparatively free from bars and islands, are characteristic of the middle and lower sections of the Tennessee River, and bear indisputable testimony as to the permanence and stability of the bed and banks of the river. The evidence of the recent survey corroborates this testimony, and shows that no material changes, due to natural causes, have occurred since the date of the earliest examinations.

The middle section has no large or important tributaries. It is fed by a great many springs, creeks, and small streams, draining areas of from a few acres to 600 square miles. The largest of these are the Sequatchie River, Paint Rock River, Flint River, Cataco Creek, Guntersville Creek, Short Creek, Town Creek, and Limestone Creek, all of which are reported to be navigable to a greater or less extent for rafts and steamboats. The total area directly drained by this section is 5,200 square miles, indicating a mean width for the valley or basin of 32 miles.

The map and profile herewith (pl. No. 1, sheets 1 to 3) of the middle section, prepared especially for this report from the maps of the survey of 1899 and other authentic sources, shows clearly and well the general course, shape, dimensions, and fall of the section. The length measured along the low-water channel line between Scott Point and Lock A is 160.3 miles, and the fall 64 feet, giving a mean fall of 0.4 foot per mile. The mean fall is not at all uniform in its distribution, even over comparatively long reaches; thus, between Scott Point and Guntersville, the mean is 0.52 foot per mile, and between Guntersville and Lock A, 0.23 foot per mile.

The mean width of the Middle Tennessee, where the bed is not occupied by islands or exposed bars, is 1,230 feet. Above Bridgeport the mean is 950 feet; between Bridgeport and Guntersville, 1,340 feet; between Guntersville and Decatur, 1,210 feet, and between Decatur and Browns Island, 1,900 feet. The actual width of unobstructed waterway at low water varies from 600 feet at Paint Rock Bluff to 2,200 feet near Browns Ferry.

The banks are usually from 20 to 25 feet high above low water, with a slope of about 4 to 1 below the level of ordinary floods, and nearly vertical above this level. They are generally composed of a tough, resisting clay, and are protected from the erosive action of the waves and current by a heavy growth of brush and trees. This growth indicates the long periods of low water and the infrequency of floods of considerable duration.

The bed of the river is composed of rock, bowlders, gravel, sand, and clay. At the obstructions the material forming the bottom is coarser and more permanent than in the pools and is frequently composed of rock reefs in place and of large bowlders embedded in coarse gravel, often completely cemented into a solid mass.

The banks and bed are practically stable for the existing conditions of slope and velocity, and a most careful investigation has failed to bring to light any evidence which indicates the contrary. The scarcity of exposed bars and islands, the entire absence of new or rapidly growing bars or shoals, the general straightness of the course, where not deflected by insurmountable obstacles, the nature of the banks, all bespeak an unusual stability. It is not claimed that the regimen is absolutely stable, or that there have been no changes, except those due to artificial causes, but it is held that the regimen is practically stable, or capable of being easily made so, and that no material changes will follow the execution of the proposed improvement by reason of increased velocity or slope.

The channel is divided by islands or bars at 14 localities, which occupy nearly 20 per cent of the total length of the section. These islands are generally large, ranging from one-half to 6 miles in length, with the channel well defined in one or the other of the chutes.

The longitudinal profile along the channel line shows the usual step-like form characteristic of rivers flowing through formations of varying resistance. The rise or shoals is generally short and well defined, and the tread or pools correspondingly long and flat, many of them having the appearance and character of lakes at low stages.

The following table has been prepared from the maps to show the number, designation, location, extent, and general character of each of the shoals or bars in the middle section. It shows the length at each obstruction over which the depth at extreme low water, along a reasonably direct channel line, is less than 3 feet, and the fall corresponding to this length; also the length and corresponding fall over which the depth at normal low water—which, as will be seen later, is assumed to be one foot higher than extreme low water—is less than 5 feet. The mean and maximum rate of fall per mile and nature of the bed are also given.

Table No. 10.—*List and character of the obstructions to low-water navigation in the middle section of the Tennessee River.*

No.	Designation.	Distance from Chattanooga to head of obstruction.	Extreme low water.				Maximum observed fall per mile.	Normal low water.				Character of bottom.
			Least depth in channel.	Length along channel line between 3-foot contours.	Corresponding total fall.	Corresponding mean fall per mile.		Least depth in channel.	Length along channel line between 5-foot contours.	Corresponding total fall.	Corresponding mean fall per mile.	
		Miles.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
1	Browns Island:											
	Lower bar	175.3	1.2	5,100	0.30	0.3	0.6	2.0	5,700	0.30	0.60	Rock.
	Upper bar	171.9	1.8	8,200	2.05	1.0	2.5	2.5	10,200	2.10	1.00	Rock.
2	Byrds Island Bar	163.8	2.2	1,650	0.15	0.4	......	3.0	2,100	0.10	0.30	Gravel.
3	Heintz Bar	161.8	3.0	......	......	......	......	4.0	4,500	0.15	0.20	Gravel.
4	South Flint River Bar	155.9	2.0	1,600	0.10	0.33	......	3.0	2,300	0.15	0.33	Gravel.
5	Limestone Bar:											
	Lower bar	153.9	2.0	2,800	0.60	1.22	......	3.0	6,000	0.70	0.65	Rock.
	Upper bar	152.1	2.3	750	0.04	0.35	......	3.3	4,200	0.28	0.35	Gravel.
6	Gillsport Bar	148.8	2.1	1,400	0.15	......	......	3.0	2,200	0.20	......	Gravel.
7	Triana Bar	143.5	3.0	......	......	......	......	4.0	3,100	0.10	0.15	Gravel.
8	Indian Creek Bar	142.8	2.1	1,250	0.40	1.70	......	3.0	1,600	0.40	1.30	Rock and gravel.
9	Lees Bar	139.9	2.0	800	0.10	......	......	3.0	1,000	0.10	......	Gravel.
10	Burdine Bar	131.1	2.0	1,400	0.50	1.95	......	2.8	2,200	0.70	1.80	Gravel.
11	Whitesburg Bar	130.7	3.0	......	......	......	......	4.0	400	0.02	0.26	Rock.
12	Chunns Bar	129.4	2.8	200	0.04	0.75	......	3.7	600	0.12	0.75	Gravel.
13	Flint River Bar	124.8	2.8	600	0.50	4.50	4.50	3.5	1,200	0.60	2.70	Gravel.
14	Allens Bar	117.9	2.8	450	0.05	0.50	0.65	3.7	3,200	0.40	0.70	Gravel.
15	Coles Bend Bar	115.7	2.8	800	0.10	0.65	1.00	3.6	3,700	0.66	0.95	Gravel.
16	Browns Bar	109.0	2.4	400	0.40	5.25	5.25	3.0	850	0.33	2.10	Gravel.
17	Beards Reef	108.4	2.4	350	0.40	5.30	5.30	3.0	600	0.40	3.50	Rock and gravel.
18	Beards Bar	107.2	2.4	4,900	0.60	0.64	......	3.2	6,000	0.70	0.58	Gravel.
19	Gunters Reef and Bar.	105.4	2.1	1,800	2.08	6.10	9.50	2.8	2,400	2.20	4.75	Rock.
20	Henrys Bar	103.2	3.5	2,000	2.00	5.25	8.50	4.2	2,000	1.70	4.50	Rock.
21	Buck Island Bar:											
	Lower bar	100.6	3.0	......	0.70	......	......	4.0	3,000	0.70	1.20	Gravel.
	Upper bar	99.1	3.2	......	1.40	......	......	4.0	7,000	1.40	1.05	Gravel.
22	Columbus Bar	98.1	3.0	......	......	......	......	4.0	800	0.10	0.65	Gravel.
23	Pine Island:											
	Lower bar	96.3	2.5	600	0.20	1.60	......	3.3	3,700	0.90	1.32	Gravel.
	Gunters Bar	94.3	3.4	......	......	......	......	4.2	1,100	0.26	1.20	Gravel.
	Upper bar	93.2	2.5	1,500	0.25	0.90	......	3.3	2,800	0.50	0.90	Gravel.
24	Romans Bar	91.8	2.5	500	0.10	1.10	......	3.3	1,500	0.30	1.05	Gravel and rock.
25	Mink Creek, or Swaffords Bar.	88.8	2.6	200	0.03	0.80	2.35	3.3	7,000	1.40	1.05	Rock and gravel.
26	Cross Bar	87.5	2.2	2,000	0.12	0.30	1.60	3.0	4,000	0.80	1.05	Gravel and rock.
27	North Santy Bar	85.9	3.2	......	......	......	1.05	4.0	4,400	0.52	0.65	Gravel.
28	Larkins Towhead	84.1	2.0	1,400	0.90	3.50	7.50	2.7	5,200	1.50	1.50	Rock and gravel.
29	Caldwells Bar	82.0	3.0	......	0.50	......	0.70	4.0	3,800	0.60	0.50	Rock and gravel.
30	Chisenhalls Bar	78.0	2.7	2,600	0.80	1.60	2.60	3.3	8,000	1.60	1.05	Gravel and rock.

TABLE No. 10.—*List and character of the obstructions to low-water navigation in the middle section of the Tennessee River*—Continued.

No.	Designation.	Distance from Chattanooga to head of obstruction.	Extreme low water.				Maximum observed fall per mile.	Normal low water.				Character of bottom.
			Least depth in channel.	Length along channel line between 3-foot contours.	Corresponding total fall.	Corresponding mean fall per mile.		Least depth in channel.	Length along channel line between 5-foot contours.	Corresponding total fall.	Corresponding mean fall per mile.	
		Miles.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
31	Jones Bar	75.2	3.0	......	0.40	......	......	4.0	4,000	0.60	0.80	Gravel and rock.
32	Bellefonte Bar:											
	Lower bar	72.8	2.0	3,900	1.00	1.60	1.70	2.7	9,800	2.00	1.05	Rock.
	Upper bar	71.8	2.1	1,600	0.45	1.50	2.00	2.8				Rock and gravel.
33	Coffee Bend	65.4	3.3	......	......	0.40	......	4.1	2,500	0.20	0.40	Gravel.
34	Crow Creek:											
	Lower bar	63.3	2.5	700	0.10	0.75	3.70	3.3	11,000	2.20	1.05	Gravel and rock.
	Upper bar	61.9	1.8	1,700	0.34	1.05	......	2.6				
35	Widows Bar:											
	Lower bar	56.2	2.0	900	0.10	0.60	4.50	2.8	7,900	1.30	0.87	Gravel.
	Upper bar	55.1	1.5	3,600	1.00	1.43	......	2.3				Rock.
36	Hembrees Bar	52.5	1.8	1,000	0.30	1.50	1.50	2.5	5,200	1.00	1.00	Gravel.
37	Bridgeport Island:											
	Island Bar	51.1	1.0	3,100	1.65	2.80	18.5	1.5	4,700	1.75	2.00	Gravel and rock.
	Bridge Bar	48.6	1.5	5,000	1.30	1.37	3.5	2.2	8,700	1.80	1.10	Rock and gravel.
	Upper Bar	47.4	1.6	2,000	0.30	0.80	......	2.4	5,200	0.70	0.75	Gravel.
38	Burns Island Bar	42.8	2.0	1,000	0.10	0.52	......	2.8	6,000	0.73	0.65	Gravel.
39	Hales Bar	33.0	2.4	1,700	0.35	1.06	......	3.2	2,000	0.46	1.20	Gravel.
40	Kellys Bar	21.8	3.0	......	......	......	......	4.0	1,000	0.15	0.80	Gravel.
41	Savannah Towhead.	20.6	6.5	1,200	1.30	6.50	23.30	7.5	1,200	1.30	6.50	Rock.
	Total mean	......	......	72,650	24.25	......	......	......	187,500	35.18	......	

A review of Table No. 10 shows that at 29 localities the depth at extreme low water is less than 3 feet. The total length in this condition is 13.75 miles, or 8½ per cent of the length of the section. The total accumulated fall is 24.25 feet, or 37.9 per cent of the whole fall between Scott Point and Lock A. The mean fall for the obstructed length is 1.76 feet per mile, and in the pools 0.27 foot per mile. At normal low water there are 41 localities where the channel depth is less than 5 feet, or where navigation is interfered with by abnormal slope or velocity conditions. The total length in this condition is 35.5 miles, or 22.1 per cent of the length of the section; the accumulated fall is 35.16 feet, or 55 per cent of the whole fall; the mean fall over the obstructed length is 1 foot per mile, and in the pools 0.23 foot per mile.

The most unusual rates of fall observed are 9.5 feet per mile at Gunters Reef, 18.5 feet per mile at Island Bar, and 23.3 feet per mile at Savannah Towhead.

The available low-water depth, according to the surveys, is less than 2 feet at the following shoals:

	Feet.
Browns Island Chute	1.2
Crow Creek Bar	1.8
Widows Bar	1.5
Bridgeport Island	1

During the survey made in 1875, by Mr. W. G. Williamson, assistant engineer, the surface velocity was measured at several of the principal shoals examined. These velocities are tabulated below:

Locality.	Date.	Stage above low water.	Length of base.	Maximum velocity for 1,000 feet per second.	Mean velocity per second.
	1875.		*Feet.*	*Feet.*	*Feet.*
Widows Bar	June 24	4.65	8,000	4.20	3.25
Crow Creek Bar	July 1	4.30	9,000	4.00	3.27
Bellefonte Bar	July 6	4.25	5,000	3.43	3.10
Larkins Towhead	July 8	4.25	5,000	4.26	2.95
Mink Creek Bar	Aug. 8	4.50	3,000	3.33	2.60

Commerce.—A careful record of the commerce of the Middle Tennessee has been kept for a number of years, and is published in detail in the Annual Reports of the Chief of Engineers. From this source the statistics for the past five years have been compiled and tabulated.

TABLE No. 11.—*Commercial statistics for Tennessee River, between Chattanooga, Tenn., and Decatur, Ala. (1895–1899).*

Articles.	1895.	1896.	1897.	1898.	1899.	Total.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Brick and tile	....	804	402	153	629	1,988
Coal	2,056	3,201	5,260	8,546	6,515	25,578
Cotton seed	1,083	966	1,009	3,920	2,965	9,943
Cotton	3,970	4,188	7,006	7,837	8,017	31,018
Fertilizer	25	....	332	1,238	....	1,595
Flour	3,874	4,143	2,922	3,500	4,938	19,377
General merchandise	9,465	13,816	17,244	12,620	29,974	83,119
Grain	13,715	13,165	33,399	17,074	25,564	102,917
Hay	47	876	1,646	1,492	2,229	7,290
Hoop poles	....	....	2,410	42	....	2,452
Iron ore	46,610	36,686	33,760	33,447	....	150,503
Iron, pig	....	375	11,107	984	1,532	13,998
Logs and wood	1,287	40,693	86,320	77,199	96,469	301,968
Live stock	234	798	1,497	2,049	2,231	6,909
Lumber	22,290	8,100	17,811	24,152	19,406	91,759
Produce	....	602	616	859	1,065	3,142
Railroad ties	....	....	311	200	1,065	1,576
Sand	8,984	2,892	17,370	19,205	27,561	76,022
Staves	66	....	....	3,000	6,085	9,151
Stone	2,500	....	5,702	6,134	17,000	31,336
Tan bark	1,150	101	1,298	805	95	4,349
Total	117,356	131,406	247,422	224,456	253,340	973,970
Estimated value	$2,099,521	$2,686,148	$4,078,228	$3,578,120	$6,118,619	$18,560,636

The table indicates a substantial and progressive increase in the quantity and value of the products transported, and shows to what extent this means of transportation is made use of on this section of the river. The figures given are significant and will bear a critical comparison with those for any of the partially improved rivers of the country away from the coast and great commercial centers. It is, for instance, ten times that of the Upper Missouri; twice that of the Cumberland below Nashville; three times that of the Muskingum; double that of the Little Kanawha; one-half that of the Big Sandy; greater by a large percentage than that of any of the following rivers: Kentucky, Green and Barren, Rough, Warrior, Tombigbee, Red, Arkansas, and White.

A knowledge of the character and dimensions of the boats which handle the present traffic, and the probable effect in these particulars of improving the section, is essential in a study of the project. This is illustrated, first, by the list and dimensions of stern-wheel boats plying the middle section, taken from the last Annual Report of the Chief of Engineers; and, second, by a list made up of the largest and best boats plying the lower section of the river, taken from the same source.

TABLE No. 12.—*List of stern-wheel steamboats plying the Tennessee River between Chattanooga, Tenn., and Florence, Ala. (1900).*

Name of boat.	Number of barges.	Length.	Breadth.	Depth.	Net tonnage.	Capacity of barges.
		Feet.	*Feet.*	*Feet.*		*Tons.*
Bessie Smith	1	127	25	2.8	50	63
B. F. Young	26	120	24.5	4	160	6,500
City of Knoxville	1	130	18	3	147	75
Clinch	4	80	16	2.1	24	130
Gladys	7	76	11	2.6	30	455
Grady	7	132.1	27	3.1	137	1,120
Gen. Joe Wheeler	4	132	18	3	65	600
Hattie McDaniel	1	90	18	2.5	67	240
Huntsville	1	125	24	4	89	180
Joe Wheeler	1	155.8	33.5	3.5	192	200
J. P. Kindrick	1	112	20	3.7	104	200
John A. Hart	....	40.7	7	2	5	....
Luke Pryor, jr	8	103	18	3	68	1,050
Mattie Ivey	1	....	....	....	3	15
N. B. Forrest	1	136	25	3.5	134	100
Ocoee No. 2	8	85	12	2.6	51	165
Sam Davis	1	118	21	2.5	93	100
W. T. Gallaher	2	77	14	2.5	27	80
Barges	18	....	....	....	....	5,559

One of the great advantages of the improvement of the middle section lies in the possibility of through shipments to and from the Ohio and Mississippi rivers; hence it is but fair to assume that the boats in this trade on the lower section will extend their business to the middle section. Consequently the list given below enables us to surmise what kind and size of craft should be provided for by the improvement in order to feel assured that the requirements of the section will be fully and economically taken care of.

TABLE No. 13.—*List of the largest stern-wheel steamboats plying the Lower Tennessee River (1900).*

Names.	Length.	Breadth.	Depth.	Net tonnage.
	Feet.	*Feet.*	*Feet.*	
City of Paducah	190	34	5.5	318
City of Sheffield	183	35	5.5	329
Clyde	175	33	5.2	335
Dolphin	136	23	4.8	156
Edgar Cherry	152	27.4	5	206
Jack Frost	165	30	5.4	350
James Y. Lockwood	165.4	33	4.5	390
Josie	146.2	28.6	4.8	233
Louis Houck	210	37	6	620
Mary M. Michael	143.3	26.8	4.4	234
Mayflower	187	44	5.5	718
Tennessee	170	32	5.5	248

All of these boats carry barges during the busy season.

Proposed improvement.—It has already been shown that the practical stability of the bed and banks is either assured or that it can be maintained by artificial works. On this hypothesis there is little room to doubt the advisability of undertaking the present improvement by regulation methods. The plans and estimates heretofore made for a slack-water improvement at Colbert Shoals and in the mountain section and the works of canalization actually executed at the Muscle Shoals afford a ready basis of estimating the approximate cost of an improvement by these means and indicate that, without considering the land and other damages due to raising the flood levels by the dams, an improvement of this nature can not be effected for much less than $4,000,000. If there was no other way to accomplish the improvement of the middle section, then an improvement, even at this cost, would be worthy of careful consideration. But since the outlook for a successful and satisfactory improvement by regulation methods is unusually favorable on account of the natural adaptability of the section to this method, it only seems necessary to thoroughly satisfy ourselves on this point before proceeding with the design of the works.

No more conclusive evidence can be found of the relative adaptability of the middle section of the Tennessee to an improvement by regulation methods than is furnished by the experience on other streams and by the statements and conclusions of engineers engaged on similar works. It is therefore proposed to briefly review the principal works of this kind in this country and in Europe, and to analyze the results obtained and the conclusions reached from a study of these works.

In this country the Ohio River, on which at low water the mean fall and discharge approximate those of the Tennessee, furnishes an example of the practical failure to improve the river as a whole by contracting the width of the bed; but the reason for this lies not so much in the system as in its application to a river of extremely unstable regimen, where the mobility of the bed and banks makes it impossible to predict or foresee the effect of contraction works, which, while benefiting a particular locality or section, frequently cause the formation of additional bars and shoals below by the deposition of the eroded materials, or the appearance of new obstructions above by the lowering of the water level, tending as a natural result, if followed to its ultimate conclusion, to the actual regulation of the whole length of the river and the reduction of the slope and velocity to a point where the bank and bed become stable. The cost of such a complete and—because of the uncertain amount of the lowering of the bed upstream—unsatisfactory improvement would be greatly in excess of that by other more certain means. So also would be the cost of an improvement which includes the regulation of the depth by protecting the bed against unnecessary scour. Consequently, the systematic improvement of the Ohio by regulation has been practically abandoned and an improvement by means of movable dams and locks substituted.

The regulation works on the Mississippi and Missouri rivers have for the same reason—that is, on account of the extreme instability of the bed and banks of these rivers, and on account of the inordinate quantity of material carried in suspension—proved unsatisfactory and unduly expensive.

The contraction works heretofore executed on the Tennessee River and its principal tributaries have not always been successful and have in some instances not only failed to better the preexisting conditions, but have made matters worse by increasing the slope and velocity or by lowering the water level in the pool above. A careful consideration of these early works indicates quite clearly that the results obtained, whether favorable or unfavorable, could generally have been predicted by the application of the hydraulic formulas and principles now used in the design of similar works. The fault of nearly all of these early works lies in an attempt to equalize the fall and increase the depth by works of inadequate length and extent. Another fruitful source of failure or partial success can be attributed to an attempt to regulate the surface fall without due regard to the slope of the bottom. These unsatisfactory results have not always come from a lack of appreciation of the importance of designing such work in accordance with natural laws, but have in many cases been due to the inadequacy of the funds provided and to the clamor of the navigation interests for temporary relief or assistance at the worst obstructions.

The final success of many of the works of regulation in Europe has not always been due to a full understanding and proper application of the underlying hydraulic principles in the first place, but rather to the persistent execution of works and the systematic observation and study of their effects, until finally the proper methods and their application have been arrived at.

Thus, on the Rhone, which has a low-water discharge 80 miles above its mouth of 10,000 cubic feet per second and a mean fall of about 40 inches per mile, it was not until millions had been expended in an almost futile attempt to secure a transverse and longitudinal profile, corresponding to the normal slope and flow, that it was realized that stability of the bed, whether natural or artificial, was absolutely requisite to success, and that the conservation of the natural longitudinal form to the greatest possible extent was equally important. After the recognition of these essential principles and their incorporation in the design of the works, no particular difficulty was experienced in securing and maintaining desired depths and conditions. It was also found possible to restore to some extent the low-water level where it had been seriously lowered by the scour caused by the early contraction works.

Although the Rhone is classed as a river of unstable regimen, it is doubtless very similar to the Tennessee in the general character of its bed, and under the comparatively moderate conditions of slope and velocity met with in the Tennessee would be equally stable, but under the unusual fall and velocity found in the Rhone it becomes highly unstable. It is asserted, however, that there are found along the Rhone many long reaches with a slope of more than 30 inches per mile where the river is stable and the natural conditions satisfactory to the navigation interests. These facts indicate to what extent the naturally favorable conditions on the Tennessee render it adaptable to an improvement by similar means.

So also on all the German and Prussian rivers where the velocity, resulting from the adoption of a normal profile and mean slope, resulted in destroying the equilibrium of the bed, it was not until the assumption of stability made in the calculations to fix the normal width was made a certainty by artificial means that success surely followed the execution of reasonable projects for improvement. The attempt to improve, by regulation, the Volga, the Moska, and other Russian rivers of large discharge, mobile bed, and moderate fall, has, as in the case of the Ohio, Mississippi, and Missouri rivers, already cited, proved either unsuccessful or unsatisfactory, and for the same reasons.

The limit to which successful improvement by regulation is possible where the stability of the bed is assured is well illustrated by the works at the cataracts of the Danube. The low-water flow of the Danube at this locality is about 50,000 cubic feet per second and the mean fall about 1.5 feet per mile with a maximum of 21 feet per mile, and comparatively long reaches where the mean exceeds 10 feet per mile. The works executed consist of canals, outlined by longitudinal dams built up to high water, excavated in the bed of the river, which is generally composed of rock, and of contracted channels formed by longitudinal dams confining all of the flow. Except at the iron gates, the excavated canals are 197 feet wide and 6 feet deep at low water, and the surface slope is frequently over 5 feet per mile. At the iron gates the width is 262 feet, the depth 9 feet, and the mean surface slope over 10 feet per mile. The velocity resulting from these conditions is very high and would be prohibitive in the Tennessee, both on account of its effect on the river bottom and because it would impede upstream navigation by means of the class of boats in use.

At the Jucz Cataract the channel was contracted by means of a longitudinal dam about 9,500 feet long and the fall of 11 feet quite uniformly distributed. The low-water level over part of this distance was raised fully 5 feet by the contraction. At the Greben Cataract, by similar works nearly 4 miles in length, the slope was made uniform and the low-water depth increased fully 6 feet for a distance of 2 miles.

The successful works on the French Broad River at the Hanging Rock Shoals described in my report of March 20, 1900,[1] on the improvement of that river, afford another illustration of what is to be expected of properly executed works under stable conditions.

All engineers who have given close study to the improvement of rivers by regulation are agreed on the general proposition that with a stable bed of suitable and uniform slope, the securing of any reasonable depth is simply a matter of contraction, and that with a stable bed of irregular form the securing of any reasonable channel dimensions, where the flow is sufficient, is simply a matter of cost.

Prof. H. Engles, of the Royal Technical School, Dresden, in his reply to the remarks made by Capt. W. R. King, Corps of Engineers, in discussing Professor Engles's paper on the "Improvement of rivers," read before the American Society of Civil Engineers in 1893, makes the following statement:

"In the case of a river with a rocky, stable bed—and to this class, according to Colonel King, the Tennessee seems to belong—a depth can certainly be obtained depending only on the following elements: (1) Available funds, (2) quantity of water at low stages, (3) admissible minimum width of channel, and (4) admissible maximum rapidity of current."

M. Pasqueau, in his report of August 15, 1878 (see Improvement of Non-Tidal Rivers, translated by Col. W. E. Merrill, Corps of Engineers, 1881), condemns the attempt to secure a normal profile and uniform slope in the Rhone and advocates the use of locks and dams in combination with a system of regulation designed to reduce the mean fall between the head of each pool and the next lock to about 12 inches per mile. Thus, while condemning the attempt to secure the natural mean slope, he acknowledges the feasibility of securing desirable results under less trying conditions.

In 1880 L. Jacquet, chief engineer of the Rhone, investigated with system and care the improvement of various European rivers by means of submerged dams or sills in connection with the usual methods of contracting the width, and in his report of September 22, 1880 (see Merrill's Non-Tidal Rivers), shows that they have been successfully used to produce artificial stability of the bed or to distribute the fall on the Elbe, Rhone, Oder, Rhine, Moselle, Weser, and Vistula. As a consequence of his investigation, M. Jacquet advised the adoption of this form of construction on the Rhone and outlined the general plans for the execution of the work, which have since been carried into effect.

The admirable paper on the "Regulation of Rivers at Low Water," presented to the Sixth International Inland Navigation Congress, in 1894, by H. Girardon, then chief engineer of the improvements on the Rhone, shows that the works executed in the manner indicated by M. Jacquet have been eminently satisfactory.

These examples of important works and opinions of eminent engineers, combined with the information herein relative to the flow, slope, and stability of the middle section of the Tennessee seem to fully justify the original statement "that the outlook for a successful and satisfactory improvement by regulation is unusually favorable."

The works and experience of others can be taken to have established the truth of the following general conclusions, reached after a study of the improvement of non-tidal rivers in connection with the improvement of the French Broad River and stated in my report of March 20, 1900 (House Doc. No. 616, Fifty-sixth Congress, first session):

1. The success of regulation works depends upon their design and execution in accordance with correct hydrotechnic principles.
2. Stability of bed, whether natural or artificial, is essential to success.
3. The natural shape, condition, and tendencies of a river should be conserved to the greatest extent consistent with the needs of commerce.
4. The plans should be comprehensive and consider the general, as well as local, effects of the works.

The examples already cited—and these could be greatly multiplied—show the necessity for applying the best hydraulic formulas and methods to the determination of the effect of proposed works and that the neglect to do this has often resulted in failures or conditions that otherwise could easily have been avoided or remedied. On the other hand, when either by accident or design works have been executed in a manner authorized by theory, the results can be shown to be in proportion to the correctness of the designs.

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[1] Printed in House Doc. No. 616, Fifty-sixth Congress, first session.

The necessity for stability requires no further argument. It has been demonstrated by every successful work of regulation ever executed. Where stability of bed is wanting, the increased velocity due to contraction gives rise to a greater scouring action, which increases the mean depth and consequently the velocity over that calculated, thus augmenting the scour until the level of the pool above begins to be lowered. As this takes place the slope is reduced until finally a condition of equilibrium is again established, but at the cost of a general reduction in the pool level above and a consequent aggravation of the succeeding shoal. It is thus made plain that when we remove one step from the longitudinal profile we must distribute the fall, formerly existing at this step, to the next one above, or we will correspondingly increase the fall and the difficulties at the upper step. Thus at La Mulatière, on the Rhone, by the improvement of the shoals below, the extreme low-water level was reduced 4.66 feet in seventeen years. It is stated, however, that by artificially restoring the approximate original profile of the bottom by means of submerged dams, designed to maintain the pools and at the same time provide a suitable channel over the shoals, the original low-water level at La Mulatière has been in a measure restored. Other instances could be given of similar experience, but it is thought that those already given are sufficient to establish the truth of all of the conclusions stated.

F. B. De Mas, in his recent work on Internal Navigation, and H. Girardon, in his paper before mentioned, lay great stress on the importance of the third conclusion and state that nature furnishes no example of a uniform slope and normal profile.

Undertaking, then, the design of the works of regulation for the middle section of the Tennessee, using the above conclusions as a basis, we are at once confronted with the fact that the science of practical hydrotechnics is far from an exact one and that the usual hydraulic formulas and coefficients can only be used with safety for the condition from which they were originally derived. This is not to be wondered at, for it would indeed be an elastic formula which would be equally applicable to a canal or a naturally uniform channel and also to a regulated channel in the bed of a river outlined by widely separated spurs on one or both sides. It requires no argument, however, to demonstrate that the questions involved are capable of at least a practical solution for any particular condition or set of conditions by means of suitably conducted experiments. These experiments should not, as has generally been the case, be superficial or conducted as a side issue, but should, on the contrary, be comprehensive and be conducted and studied as the main issue in the solution of the technical questions connected with the design of regulation works. Until such experiments are undertaken, and the results become available for use, it will be necessary to rely on general observations not taken for this special purpose, and it will be desirable in executing the works to allow a liberal margin for safety by using some form of construction which lends itself to an easy and economical modification.

It is the writer's opinion that the insufficiency of the usual hydraulic formulas for practical use is due to a large extent to their failure to take account of the effect of the velocity of approach.

The most generally accepted formulas for calculations connected with the flow of water in open channels are based on the Chezy formula,

$$v = C\sqrt{RS} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

in which v represents the mean velocity in feet per second, C a coefficient determined by experiment, R the hydraulic mean depth, and S the slope per foot.

The successful application of this formula to a particular case depends upon the proper selection of a value for the coefficient (C), which, although it has received the earnest attention of many of the most eminent hydraulicians of the age, is still involved in much uncertainty. Although the selection of a proper value for this coefficient was discussed in considerable detail in my report on the French Broad River, this discussion related more particularly to small rivers of high slope, small mean depth, and comparatively low discharge, and consequently does not apply to the Tennessee. It has therefore been attempted, from a comparison of the coefficients obtained from the observations on a number of rivers of somewhat similar character to the Tennessee and from observation on the Tennessee itself, to deduce coefficients that can be safely used in the present calculations.

For this purpose there has been platted on the diagram herewith (pl. No. 4, fig. 4), using as coordinates the mean hydraulic depth and the values of the coefficient (C), the results of 50 observations made at Riverton, Ala., in 1899 (from Annual Report of Chief of Engineers, 1899), of 5 miscellaneous observations on the Tennessee (from Annual Report of Chief of Engineers for 1896); of 8 observations on the Fox and Wisconsin rivers (from Warren's report, 1876); of 1 observation on the Dneiper; of 17 observations on the Rhine (from Kutter's Tables); and of 8 values used in the calculations for the Rhone (from Merrill's Non-Tidal Rivers). This diagram shows a wide and inexplicable variation in the values of the coefficients and illustrates the necessity for special determinations. The Tennessee River values are generally consistent, but do not include a sufficient number of observations when the mean depth was slight. The Fox and Wisconsin observations make up in a measure this deficiency, and it is not improbable that a curve based on these two sets of observations would correctly represent the mean values of the coefficient for similar conditions. The values obtained from European sources are, with but few exceptions, so much larger than those already considered that they cast a doubt over all, and make it exceedingly difficult to reach satisfactory conclusions. It has been decided, however, to use the values represented by the curve drawn on the diagram. This curve passes between the American and European values, and for depths of less than 6 feet gives values 5 to 10 per cent greater than the American and 10 to 15 per cent less than the European experiments.

Using the values of C, given by the curve shown on plate 4, figure 4, we can proceed with the determination of the probable mean velocity in the proposed channels and the dimensions of the channels themselves for given conditions of discharge, depth, and slope by means of formula (3).

In order to simplify the calculations it is customary, when, as in the present case, the width of the channel is great as compared with the depth, to make use of the mean depth (D) and the mean width (W), instead of the hydraulic mean radius (R) and the wetted perimeter of the sections. The results obtained in this manner for the Middle Tennessee are probably as accurate as the data used.

Substituting D for R, and $\frac{Q}{W \times D}$ for v, in formula (3), we obtain the following expression for the mean width:

$$W = \frac{Q}{C\sqrt{D^3 S}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

The maximum velocity in the proposed channel can be approximately determined by using the following formula, devised by Bazin:

$$\text{Maximum velocity} = \text{mean velocity}\left(1 + \frac{25.4}{C}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

These three formulas—(3), (4), and (5)—afford the means of determining the approximate effect of any reasonable combination of the quantities or elements entering into them.

The solution of the various questions requiring the use of these formulas is much facilitated by the following table, which has been prepared to show the mean and maximum velocities resulting from given combinations of the slope and mean depth, and also the mean channel width for the same conditions, corresponding to a discharge of 1,000 cubic feet per second. The mean width of channel for any other discharge will vary from that given in the same proportion that the discharge varies.

TABLE No. 14.—*Probable mean and maximum velocities and mean widths of channel for flow of 1,000 cubic feet per second, resulting from the conditions shown.*

[Velocity in feet per second. Mean width in feet.]

Coefficient (C).	Mean depth (D).	Fall of water surface in feet per mile.											
		0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	
		Fall of water surface in feet per 1,000 feet.											
		.095	.142	.189	.284	.379	.473	.568	.663	.757	.852	.947	
65.2	3.0	1.10	1.35	1.55	1.90	2.20	2.46	2.69	2.91	3.10	3.30	3.48	Mean velocity.
		1.53	1.87	2.16	2.64	3.05	3.41	3.74	4.04	4.32	4.58	4.83	Maximum velocity.
		303	248	215	175	152	136	124	115	107	101	96	Mean width.
67.0	3.5	1.22	1.49	1.72	2.11	2.44	2.73	2.99	3.23	3.45	3.66	3.86	Mean velocity.
		1.69	2.06	2.43	2.92	3.36	3.76	4.12	4.45	4.75	5.04	5.32	Maximum velocity.
		234	191	166	135	117	105	96	88	83	78	74	Mean width.
68.3	4.0	1.33	1.63	1.88	2.30	2.66	2.97	3.26	3.52	3.76	3.99	4.20	Mean velocity.
		1.83	2.24	2.58	3.16	3.65	4.08	4.47	4.83	5.16	5.48	5.77	Maximum velocity.
		188	154	133	109	94	84	77	71	67	63	60	Mean width.
69.3	4.5	1.43	1.75	2.02	2.48	2.86	3.20	3.50	3.79	4.05	4.29	4.53	Mean velocity.
		1.96	2.30	2.77	3.39	3.92	4.37	4.79	5.17	5.53	5.87	6.19	Maximum velocity.
		155	127	110	90	78	70	64	58	55	52	49	Mean width.
70.0	5.0	1.53	1.87	2.15	2.64	3.05	3.41	3.73	4.03	4.31	4.57	4.82	Mean velocity.
		2.08	2.54	2.93	3.60	4.16	4.64	5.08	5.50	5.87	6.23	6.56	Maximum velocity.
		131	107	93	76	66	59	53	50	46	44	42	Mean width.
71.2	6.0	1.70	2.08	2.40	2.94	3.40	3.79	4.16	4.49	4.80	5.09	5.37	Mean velocity.
		2.30	2.82	3.25	3.99	4.61	5.15	5.64	5.09	6.51	6.91	7.28	Maximum velocity.
		98	80	70	57	50	44	40	37	35	33	31	Mean width.

The probable effect on the calculated mean depth of a change in the adopted values of the coefficient (C) is illustrated by the following calculations, which assume that the width (W), the slope (S), and the discharge (Q), for any particular case, are fixed. From these conditions it can easily be shown that

$$D' = \left(\frac{C^2 D^3}{C'^2}\right)^{\frac{1}{3}} \quad \text{.......................... (6)}$$

in which D represents the calculated mean depth for given channel width, slope, discharge, and adopted value of C and D' represents the calculated mean depth for same conditions, and a new value, C', for the coefficient. Using this formula we obtain, by increasing and decreasing the adopted values of C 10 per cent, the following:

C	68.3	69.8	70	Adopted values.
D	4.0	4.5	5	Assumed mean depth.
C′	75.0	76.0	77.0	Coefficient increased 10 per cent.
D′	3.76	4.23	4.70	Corresponding mean depth.
C″	61.0	62.0	63.0	Coefficient decreased 10 per cent.
D″	4.81	4.85	5.37	Corresponding mean depth.

These figures indicate that within the limits used that an increase of 10 per cent in the adopted coefficient will result in a decrease of approximately 6 per cent in the mean depth, and that a decrease in the adopted coefficient of 10 per cent will result in an increase of approximately 7¾ per cent in the mean depth. An increased mean depth will for the fixed conditions result in a corresponding decrease in the mean velocity and vice versa.

A glance at the longitudinal profile of the middle section (pl. 1, sheets 1 to 3), shows at once the utter impracticability of attempting to secure a uniform slope over the whole section, even if this had not been already found objectionable where the physical conditions indicated its possibility. Consequently it is proposed in the present case to change the fall between the pools as little as possible, and to conserve the natural shape and tendencies of the river by simply equalizing or making uniform the slope over the shoals by means of excavated channels, or by contraction works, or by both, to such an extent as to make navigation safe and easy. To this end the limits of slope and velocity, compatible with safe and easy navigation, and the depth and width necessary for economical and successful navigation, will be determined from a review of the examples, information, and data furnished by other rivers and improvements. The channels over the shoal reaches will then be designed in accordance with the principles heretofore outlined, so as to keep within these limits.

Normal stage.—Since it is entirely impracticable to design works suited to every condition of stage and discharge, it becomes necessary to select the condition or stage which will best subserve all interests. It is usual to select the normal low-water stage, and to base all calculations and designs on securing given results for the conditions then existing. The Tennessee is shown by the tabulated hydrological data submitted herewith to be normally a low-water stream. From Tables Nos. 5 and 6, and the diagrams based thereon, the mean high-water period is seen to be marked, and to cover the months of January, February, March, and April. The mean low-water period is equally marked and covers the remainder of the year. The normal low-water stage, or the stage which it is natural to expect the river to reach each year, is well determined by Table No. 7, which shows the actual and mean number of days the river at Chattanooga has been above given stages during a period of twenty-six years. The stage has been less than 1 foot for periods of varying length during ten years and less than 2 feet during twenty-three years. From this it can be shown that a 1.3-foot stage is that which, according to probability, is likely to be reached each year. If, then, in order to be on the safe side, we adopt 1 foot as the normal low-water stage, we have the assurance of the records that the stage at Chattanooga will exceed this normal 97 per cent of the time, and that it will not be less than 0.5 foot more than 1 per cent of the time, or about seventy-five days in twenty-six years.

The effect of an increase or decrease in the discharge through channels of fixed dimensions or conditions is illustrated by the following: It can be shown for a channel of given width that

$$D' = \left(\frac{Q'^2 D^3}{Q^2}\right)^{\frac{1}{3}} \quad \text{.................................. (7)}$$

In which D and Q represent the normal mean depth and flow, and D' the mean depth corresponding to any other flow (Q'). Using a discharge of 10,000 cubic feet per second and mean depths of 4 and 4.5 feet as bases of comparison, the effect of both increasing and decreasing the flow has been calculated by equation (7), and tabulated as follows:

Discharge.	Mean depths.		
	Feet.	Feet.	
Cu. ft. secs.			
10,000	4	4.5	Assumed.
4,000	2.16	2.44	Mean depths calculated for given discharge.
6,000	2.85	3.19	Do.
8,000	3.45	3.88	Do.
15,000	5.24	5.97	Do.
20,000	6.35	7.14	Do.
25,000	7.37	8.29	Do.
30,000	8.35	9.36	Do.

The difference between the mean and maximum depths in a channel of the form now proposed, for any discharge, will be approximately the same as for the normal flow. Hence for a channel whose mean depth is 4 feet and maximum 5 feet, the difference will remain about 1 foot, so long as the flow is all confined to the regulated channel. The velocities will change with the mean depth for given conditions of slope, approximately, as shown by Table No. 14, until the works defining the channel are submerged, then the velocities will gradually become due to the changed slope and the mean depth of the whole waterway.

Normal low-water discharge.—The discharge corresponding to the adopted normal low-water stage, which is one foot above extreme low water at Chattanooga, obtained by means of formulas (1) and (2), is 8,455 cubic feet per second at Chattanooga and 10,330 cubic feet per second at Riverton. The increase between these points can be assumed, without material error, to be progressive. This assumption is graphically shown on plate 4, figure 5, which enables a determination by inspection of the normal flow at each obstruction or locality considered.

Limiting conditions.—Other things being equal, the nature and extent of the probable commerce and the dimensions of the craft carrying it should be the leading factor in fixing the economic dimensions of the cross sections of the regulated channels at normal low water. From this standpoint we would be inclined to conclude that a channel depth of at least 6 feet was necessary, because, when free and unobstructed navigation is provided, there is little room to doubt that the largest boats now navigating the lower river will ascend to Chattanooga. Many of these boats, as shown by Table No. 13, are capable of being loaded to a draft of 5 feet, which draft, according to the experience of the French and German engineers, requires a channel depth of at least 6 feet. It is useless, however, to consider the question from this standpoint, because the limit has already been fixed by the construction of the Muscle Shoals Canal, which provides a depth of only 5 feet on the lock sills, and thus limits the draft of boats passing from the lower to the middle section of the river, and without argument fixes the least depth necessary at normal low water in the new channel at 5 feet.

In discussing the minimum channel dimensions to be adopted in the improvement of the French Broad River it was shown from a consideration of the practice elsewhere that a width of about 100 feet had proved sufficient under certain circumstances, notably on the Dneiper, where the canals excavated in the channel and outlined by dams were made 105 feet wide. On the Tennessee a channel width of from 100 to 150 feet has generally proved satisfactory, except during high winds.

At the cataracts of the Danube a minimum width of 196 feet has been used.

In the present case, because the normal flow of the river is sufficient to allow of almost any desirable channel dimensions, the width and form of section becomes an economic question. Viewed from this standpoint it is proposed to base the present designs and estimates on a section providing at normal low water a depth of 5 feet over a width of at least 100 feet along the line of a suitable boat track. Beyond the zone of 5-foot depth the natural form of the section is to be retained to the greatest extent consistent with the desired results, removing only the lumps, reefs, and other detached obstructions from the waterway. Where the sides of the excavation are high and steep, and it is not practicable to give them a gradual slope to the natural bottom, it is proposed to widen the cut.

It is intended by care in the location of the works and the area of deepest water to reduce to a minimum the quantity of excavation and the extent of the contraction works necessary to secure the width and mean depth, corresponding to the fixed conditions of slope and discharge. In case this can not be economically done by means of a contracted channel of uniform mean depth and width, it is proposed to vary both of these quantities to suit the natural conditions, when this course is not inconsistent with the requirements of the improvement.

The determination of the mean depth that will follow the execution of given works of regulation is involved in more or less uncertainty, and will require for exact results much more detailed surveys than are now available. The effect of an error in this particular will, for given conditions of slope, width, discharge, and water-surface elevation, be equal to the extent of the error.

In regard to the limiting velocity and slope, it requires no argument to show that they should, in the interest of safe and economic navigation, be as low as possible, and thus also provide against an increase in the velocity to dangerous limits during high stages.

In this connection, it is interesting and instructive to note the limiting slopes and velocities allowed on some of the European rivers. On the Rhone, at normal low water, the mean slope is 40 inches per mile, and at some of the worst obstructions a mean of 10 feet per mile is allowed. The observed maximum velocity at this stage ranges from 3.3 to 7.4 feet per second, and for floods from 7.4 to 13.1 feet per second. The great width of channel on the Rhone—500 to 1,300 feet—as will also be the case on the Tennessee, makes it easy for boats to avoid the swiftest water during floods.

In the improvement of the cataracts of the Danube slopes of from 5 to 13 feet per mile, resulting in maximum velocities of from 7 to 15 feet per second, have been deliberately adopted.

The mean velocity and slope in the regulated channel of the Memel for normal conditions are 2.25 feet per second and 0.5 foot per mile.

In his very able and interesting paper on the Cataracts of the Dneiper, read before the Sixth Congress of Inland Navigation, M. V. E. de Timmoff discusses these questions at length and reaches the following conclusion:

"The velocity of current should not be more than 6 feet per second, and it is proposed in future to reduce it as much as possible. The length of the canals (regulated channels) should be at least such that the mean incline is not much over 0.001 per meter (5.25 feet per mile), a figure we are inclined to consider as the maximum limits for navigable rivers. But provisionally, perhaps more pronounced inclines will be tried, without probably adopting an incline of more than 0.002 per meter (10.5 feet per mile), which is more or less the limit between torrents and rivers."

A preliminary review of the situation on the Tennessee shows that, with due regard to economy, it will not be necessary to exceed a slope of 4 feet per mile, and that generally a much more favorable slope can be used. For this slope the maximum velocity at normal low water will probably not exceed 5.6 feet per second. These limits are well within those set by M. de Timmoff, and furnish another argument to show the unusual adaptability of the Middle Tennessee to a satisfactory improvement by regulation.

Means and systems of regulation.—The regulation of rivers of slight and uniform fall, large discharge, and stable bed can usually be safely effected by dredging or excavating channels of predetermined dimensions through the shoals. When, however, the fall at the obstructions to be improved varies much from the mean, it becomes necessary to counteract by contraction works the effect of enlarging the waterway. When the obstacle is due to an unequal or abnormal distribution of the fall, or when it is desired to avoid costly excavation, the regulation of the channel can be effected by contraction works at or below the obstruction, designed to reduce the width and depth and thus raise the water surface so as to produce calculated conditions.

The regulation works for these purposes may consist of—

1. Properly disposed spur dams extending out from one or both banks. These spurs may be in whole or in part submerged, and thus outline not only the width, but also the depth and slope, of the proposed channel.
2. Longitudinal dams or dikes running parallel to each other or to the bank of the river, defining the width of the proposed channel.
3. A combination of either or both of these methods with dredging, excavation, or sills to outline the depth and shape of the proposed channel.

Each of these systems has its advocates and advantages, but the best results doubtless follow the judicious combination of them all (3). The German engineers are partial to spurs and sills, while the French favor longitudinal dams and sills.

If it were possible to determine in advance by calculation exactly the proper width to give the channels, then it appears that longitudinal dams are preferable and result in a more equable distribution of the fall, but until the science of hydrotechnics reaches a perfection that will allow of such a determination spurs possess a great advantage, in that they are capable of being lengthened or shortened at small expense, so that full advantage can be taken of the experience gained in the field. With narrow channels and high velocities longitudinal dams are much more necessary than with the wide channels and comparatively low velocities proposed for the improvement under consideration. With dams of low relief, such as are now proposed, there is less likelihood of cross currents with spurs than with longitudinal dams, unless frequent cross dams connecting with the shore are used.

In speaking of low longitudinal dams, M. Girardon, in his memoir before referred to, says:

"When the water rises above the dike absolutely pernicious effects may be produced. The water by flowing over the dike may undermine it, secondary currents may be created behind it, and boats may be drawn against it by the cross currents caused by the overflow."

According to Mr. R. R. Thacher, who has been in local charge of the works of improvement on the Upper Tennessee and tributaries for many years, the draft over low longitudinal dams is highly objectionable and dangerous.

Another feature favorable to spurs for works constructed of loose riprap is that the leakage or loss of available flow will be less, and that due to the length of a single spur, while with longitudinal dams, unless frequent cross dams are used, the leakage will be cumulative and for very long dams may reach undesirable proportions.

Many of the arguments for and against these means of contraction are based on their relative merits as silt catchers and builders up of new banks, and consequently do not now have the same weight as in the case of less stable streams, although even on the Tennessee we can fairly assume that the proposed works will eventually result in the formation of new banks and in the filling up of the bed between the sills.

In view of the foregoing, it is proposed to base the designs and estimates for the present works on the use of spurs, supplemented by excavation and submerged sills. Generally speaking, an improvement by these means will prove cheaper in first cost than if longitudinal dams were used, and this is particularly true if cross dams are used to connect the longitudinal dams with the shore.

There appears to be no well-defined rule or custom as to the proper distance to be left between spurs or sills. It is certain, however, that they become more effective in producing uniform channel conditions as they are placed closer together.

In Professor Schlichting's work on the "Regulation and Canalization of Rivers," translated by Lieut. Fred. V. Abbot, Corps of Engineers, 1885, he states that on the works on the Memel, carried out under his supervision, the distance between spurs on straight reaches was five-sevenths the normal channel width; on concave banks, where short spurs were necessary, the distance was reduced to one-half, and on convex shores, where the object was mainly to hold deposits, the distance was made equal to the channel width. These distances were based mainly on a consideration of the effect of the spurs in producing deposits or causing the erosion of the banks between them.

From the maps in Schlichting's work, showing the works of regulation on the Elbe River, it is seen that the distance between the spurs varies from one-half to nine-tenths the channel width, depending upon the length of the spurs or whether the reach was straight or curved. For a short spur on a concave bank the distance is one-half the channel width, while on straight reaches, where the length of the spur is greater than half the width of the channel, the distance is nearly equal to the channel width, but for shorter spurs the distance is generally made equal to the length of the spurs.

The maps showing the works on the Rhone, given in Girardon's paper and elsewhere, show the distance between sills to vary from two-thirds to nine-tenths the channel width, and between spurs from three-fourths to one and one-half times the channel width.

On the Rhine, for a normal width of about 1,150 feet, according to Jacquet, the distance between sills varies from 400 to 800 feet. He states that it is probable that spurs and sills should be about 300 feet apart in order to produce a complete and regular fill between them.

From these considerations it has been decided in the present plans to space the spurs and sills from one-half to three-fourths the channel width, except where the spurs are short, when the distance will be made about equal to the length of the spurs.

It is not thought that the angle which the spurs make with the shore is of particular importance on a stable stream, where the formation of new banks and deposits is not a special feature of the improvement. According to the experience in Germany, the best results follow an inclination upstream of from 75° to 80°. In Holland an angle of 90° is found the most satisfactory. In France the German custom is generally followed. The main argument in favor of an upstream inclination is that it gives the water flowing over the dams a direction from the banks and thereby protects them against erosion.

The effect of regulation works, whether consisting of spurs, longitudinal dams, sills, or combinations of these, is set forth by M. Girardon in his valuable paper as follows:

"It is still more natural from a technical point of view to say that if the water flows over different inclines, the fact is connected with the diversity of profiles and that by regulating the profiles the incline will also be regulated. * * * This argument would not raise any very serious objections if the bottom were stable. * * * Let us consider a long section of river confined by regulation works. The first effect of confining the bed is to increase the incline, and the depth and the flow continue as though the bottom were fixed. * * * Thus, while on a resisting water course the confinement produces an increase in the incline, on a river with an unstable bottom the contrary takes place. * * * This grave inconvenience can not be obviated by works of this nature except by increasing the resistance of the bottom at the same time as the effective force of the current which acts upon it is increased."

Height of dams.—The range of stage for which it is considered necessary to contract the flow in order to produce given conditions and the effect of the works in producing abnormal conditions at high stages are the principal factors in fixing the height of the dams. The works proposed for the Middle Tennessee are expected to result in producing the calculated depths, width, slope, and velocity at normal low water; hence, under ordinary circumstances it would appear advantageous not to carry the tops of the spurs much above this stage. Any greater height than this would result in increasing the velocity, so long as the flow was contracted, in the ratio shown by Table No. 14, whereas, by keeping the works low and allowing the water to spread out over a large area, this effect can be greatly modified. The effect of the works in producing disturbances at high water will be in proportion to their height.

Professor Engles says: "If the slope is adjusted for low water, then in a uniform and rationally formed channel this will also obtain with higher stages of water." It is consequently advised that the crests of the spurs be placed not higher than 1 foot above the adopted normal low-water stage. This height is considered necessary to properly build the crest and make it permanent at reasonable cost.

The proper depth of the submerged sills below normal low water, in order that they shall not produce undue disturbance of the water surface and interfere with the steering qualities of boats, is still an open question and can only be definitely settled by actual observations. On the Rhine it was found that when placed 8 feet below low water they produced absolutely no inconvenience. At this depth, however, they lost much of their effectiveness in equalizing the slope and raising the water levels. The high velocity and slope on the Rhone would add so greatly to the effect of sills that it seems reasonably safe to say that a depth of 6 feet would be ample for the Tennessee for a width of 100 feet in the main channel. This extra depth must be compensated for by reducing the channel width if it is desired to equalize the fall to the greatest extent. On some of the smaller rivers of Germany sills have been successfully used at much less depths than 6 feet.

Construction materials and form of works.—The abundance, general availability, and consequent cheapness of stone and its adaptability to the construction of dams make its use desirable. The great width of the proposed channels modifies the objectionable effect of riprap structures, which, by reason of this roughness, produce unusual disturbances in the water in their immediate vicinity. It is consequently proposed to use riprap dams and sills to the greatest possible extent. The dams will have a top width of 8 feet, with side slopes of 1 to 1, the body of the dams being composed of loosely disposed riprap stone or dredged materials, the crest being formed of selected large stones, laid with care, so as to present a reasonably smooth surface. At the outer ends of the spurs the side and end slopes will be made much flatter, and at the shore ends the height will be slightly increased and the adjacent bank suitably protected against erosion by a covering of riprap. Gravel and other suitable materials, excavated from the channel, will be largely used to make the dams tight by disposing it either in the heart of the dams or along their upstream side.

The protection of the banks by riprap wherever necessary forms an essential part of the project. It is not thought, however, that much of this class of work will be necessary on account of the resisting nature of the banks.

Estimates.—The determination of the probable cost of works of the extent and magnitude of those contemplated in the present project is of great importance, and a conscientious effort has been made to arrive at safe and just conclusions as to the proper units to use in the estimates. The conclusions stated are premised on the use of modern methods and appliances under appropriations sufficiently liberal to allow the work to be prosecuted in a practical and economical manner without unusual charges for contingencies and general supervision. The works heretofore carried ou. on the Tennessee and its tributaries should, if considered with a knowledge of the circumstances under which the work was done, afford the best means of determining these units. The earliest of these works of channel improvement were done entirely by hand in the most primitive manner. The resulting units are in consequence very high. Later, by the use of hand derricks and other simple appliances, the cost was materially reduced. Still later, by the use of steam dredging machinery, steam drills and derricks, a further reduction was made—thus illustrating by each step the advantage and economy of modern appliances, and to what extent it will probably be possible to reduce the cost of similar works. The following table has been compiled from the more recent reports covering the works on the Tennessee River:

TABLE No. 15.—*Cost of channel excavation on the Tennessee River (1895-1900).*

Year.	Locality.	Quantity.	Material.	Cost per cubic yard.	Method used.	Remarks.
		Cub. yds.				
1895	Bridgeport Island	4,578 3,000	Clay and gravel .. Bowlders	$0.35	U. S. dredge Harwood.	Exhibit 10a.
1895	.....do............	890	Solid rock........	4.16	Largely by hand	Do.
1896	.....do............	1,421 3,104	Bowlders .... Clay and gravel..	.29	U. S. dredge Harwood.	Exhibit 10.
1896	Gunters Reef.....	806	Solid rock........	2.50	Hand drills and derrick boat.	Do.
1896	Beards Reef......	501	.....do............	3.40	.....do...............	Do.
1896	Flint River Bar ..	8,000	Clay and gravel and bowlders.	.26	U. S. dredge Harwood.	Do.
1896	Caney Creek Shoals.	1,300	Solid rock........	1.81	Steam drill and derrick boat.	Annual report, 1896.
1897	Bridgeport Island	285	.....do............	2.04	.....do...............	Exhibit 10.
1897	Beards Reef......	9,385	Loose rock and gravel.	.21	U. S. dredge Harwood.	Do.
1897	.....do............	190	Solid rock........	1.44	Derrick boat..........	Do.
1897	Sweetwater Bar ..	8,597	Loose rock and gravel.	.20	U. S. dredge Harwood.	Annual report, 1897.
1897	Florence Bar.....	4,100	.....do............	.14	.....do...............	Do.
1898	Williams Island ..	4,411 1,441	Gravel .... Rock..............	.26	.....do...............	Annual report, 1898.
1898	Ross Towhead....	6,757 1,764	Solid rock........ Gravel	.26	.....do...............	Do.
1898	Lower Tennessee.	1,000 27,965	Solid rock .... Gravel, etc	.29	Loomis & Hart dredge	Do.
1899	.....do............	800 47,514	Solid rock........ Gravel, etc	.21	U. S. dredge Harwood.	Annual report, 1899.
1900	.....do............	82,000	Gravel and sand.	.08	U. S. dredge Kentucky	Annual report, 1900.

The above figures represent only the field cost, and do not therefore include the cost of plant or of general repairs and supervision. The U. S. dredge *Harwood* proved entirely too weak for the heavy work often met with, and the U. S. dredge *Kentucky* was designed by you especially for this class of work, and has by the last season's work shown her eminent fitness for it. She has a capacity under favorable circumstances of 5,000 cubic yards per day, and her record for the season's work is about 5 cents per cubic yard for sand and gravel and 25 cents per cubic yard for cemented gravel requiring blasting.

The bottom of the river at the obstructions on the Middle Tennessee is rarely composed entirely of solid rock, but generally of detached reefs, extending above the general level of the bottom, of cemented gravel or of large bowlders embedded in coarse gravel or clay. For the gravel and clay, including some loose rock, the experience of the past five years has shown conclusively the progressive decrease in cost with the addition of improved facilities, and indicates that we can safely assume 10 cents per cubic yard as the field cost of this class of work where the quantity involved is large, or the work well located. Using this price as a basis, and making liberal allowance for cost of plant, general supervision, delays, location, and repairs, a unit price of 25 cents has been deduced for this class of work. For solid rock it is more difficult to reach a conclusion, because the work heretofore done has been much scattered and of such small amounts that adequate facilities for properly handling it have not been provided. Consequently the units given in the table do not afford a fair basis of determination.

The works at Caney Creek in 1896, and at Bridgeport and Beards Reef in 1897, amounting to a total of 3,600 cubic yards, give a mean cost of $2 per cubic yard. It is thought that in view of the much greater quantities to be handled under the proposed project, and of the better and more powerful appliances that will be at hand, a unit price of $1.50 per cubic yard can be made to cover not only the field cost of this class of work, but also to include the cost of special plant, supervision, and repairs.

The cost of handling loose rock, where it exists in considerable quantity, will be estimated at about 50 cents per cubic yard.

The works on the Upper Tennessee and tributaries afford the best criterion of the cost of building riprap dams, when the work is carried out on a comparatively small scale. On the French Broad River, in 1896, the actual field cost of quarrying 2,500 cubic yards of riprap and placing it in the dams was 88 cents per cubic yard, divided about equally between quarrying and placing in dams. At Caney Creek Shoals, in 1896, the cost of 2,100 cubic yards of riprap placed in the dams was $1.20 per cubic yard. In a private letter from Mr. R. R. Thacher, who has been for years in the local charge of these works, it is stated that $1 per cubic yard is a safe estimate for riprap placed in the dams for the average condition met with. For works on the scale of those now proposed for the Middle Tennessee, in a country where suitable quarries are found everywhere, it appears from a detailed review of the elements entering into the field cost that riprap can be quarried and placed in the dams for 75 cents per cubic yard. If to this we add 25 cents per cubic yard for plant and general supervision, making the cost $1 per cubic yard where it is necessary to specially quarry the materials, we will be on the safe side for all ordinary conditions.

In many localities the materials excavated from the channel will be made use of to construct or to make the dams water-tight. In such cases this fact will be taken into consideration in estimating the cost of the completed works.

DESCRIPTION OF THE OBSTRUCTIONS AND DETAILED PROJECTS FOR THEIR IMPROVEMENT.

Having thus outlined generally the data and considerations on which it is proposed to base the plans for the improvement of the Middle Tennessee, it remains to show their direct application to the design of the individual works.

In order that each work shall derive the full effect of those adjoining it, whether this effect is beneficial or otherwise, it is essential to begin with the lowest obstruction and work upstream. From a study of the map and profile of the locality to be improved, it is possible to decide on the best location for the regulated channel. The probable effect of the works at high water and the amount of work involved in their execution are the prime factors in the selection. In the same way the slope of the bottom of the channel best suited to the locality is determined. If for this slope and the available normal low-water flow the necessary width and depth can be secured, and the resulting velocity does not exceed a safe limit—all of which is easily determined from Table No. 14—then we can proceed to locate the necessary works on the map and to estimate the cost of their execution.

The surveys on which the maps are based were made in more than usual detail for a general survey, and are complete and satisfactory for a general study of the improvement.' Nevertheless, when it comes to determining exactly the dimensions of a channel resulting from a given location of works, or the exact quantities entering into their composition, the maps are not sufficient, and special surveys in greater detail will be necessary to each obstruction in connection with the final location and execution of the improvements. It has been attempted in using the maps to cover this contingency by estimating on the safe side; still there is no assurance that this has always resulted satisfactorily. The fall to be overcome at each obstruction is known definitely, and this knowledge fixes the length of channel to be regulated for the selected slope, leaving us somewhat uncertain as to the exact height of the dams above the bottom and the exact amount of excavation necessary.

As before stated, it is proposed to use spur dams as the means of outlining the regulated channel. However, if for any reason some other method of regulation appears better suited to the locality this method will be used. It is not possible in the present state of practical hydraulic knowledge to say positively that any given means of executing a project is the best; consequently, it is not intended to fix the means in the present case, but to outline a method which appears to be the best whereby the improvement can be effected at the probable cost stated.

Constant and systematic study of the effects of the works as executed in the light of the actually existing conditions of slope, depth, and flow should be kept up at least until these effects are fully understood and incorporated in the designs.

Each obstruction given in Table No. 10 which impedes navigation at normal low water, either by reason of excessive fall and velocity or because the depth over a channel of suitable direction and width is less than 5 feet, will be taken up in the order shown and described in detail as to past and present condition, with an historical review of all that has been heretofore done to study or ameliorate its condition. And finally, the details of the method and means now proposed for its improvement and cost of same will be given.

No. 1. Browns Island Chute (171 miles below Chattanooga).—The left chute at Browns Island has been extended by means of a long riprap dam from the lower end of the island to Lock A, at the head of the upper or Elk River division of the Muscle Shoals Canal, and thus forms the only means of access to the canal from above. The dam connecting Lock A with Browns Island follows along nearly parallel to the left bank of the river from the lock to Miltons Bluff, practically extending the canal upstream a distance of about 1¼ miles. The width of this section varies from 150 to 300 feet, although the depth is not generally sufficient for navigation purposes except over an area of about 75 feet wide along the dam. Above Miltons Bluff the waterway widens rapidly, and 2 miles above Lock A the dam turns at an angle of nearly 90° to the left for 600 feet, and then runs for nearly one-half mile directly to the point of the island. (See pl. No. 6.)

Two main obstructions are found in this chute, the first which is designated in Table No. 10 as the "lower bar," extends from 3,000 feet below to 2,000 feet above the angle in the dam. The channel here is very shoal. At extreme low water the available depth is but 1.2 feet, and the depth is less than 3 feet for a length of 5,000 feet. At the normal low-water stage the available depth will be about 2 feet, and the length between 5-foot contours 5,700 feet. The surface slope is flat and comparatively uniform.

The "upper bar" begins about 1 mile below the head of Browns Island. At extreme low water it affords a channel depth of 1.8 feet, and has a length of 8,200 feet between 3-foot contours. At normal low water the available depth will be about 2.5 feet, and the length between 5-foot contours 10,200 feet. The total fall is 2.1 feet, giving a mean of 1 foot per mile. The maximum fall is 2.5 feet per mile, and occurs where the channel has been already outlined by excavation and dams. The bottom throughout the chute is generally solid rock.

Historical.—The original plans for overcoming the Elk River Shoals contemplated the construction of a canal on the right bank of the river from Browns Ferry to the present Muscle Shoals Canal. (See Exhibit No. 3.)

In 1877, on the recommendation of Capt. W. R. King, Corps of Engineers, the plan was changed so as to make use of the 5 miles of deep waters between the Elk River and the Muscle Shoals, and of the left chute at Browns Island. It was estimated that a saving of almost $400,000 could thus be effected. The details of this plan, which was practically followed in the construction of the Elk River Canal, are clearly set forth in the report of Mr. Paul Le Hardy, assistant engineer, given herewith as Exhibit No. 6a. The work of excavating a channel in Browns Island chute intended to provide a width of 125 feet, and a depth of at least 3 feet at extreme low water was commenced in 1878, and completed in 1882, during which time nearly 40,000 cubic yards of rock was excavated and placed in the dams outlining the channels. These works are described in Exhibit No. 6, and are shown on plate No. 6 herewith. The channels have proved inadequate and unsatisfactory, and have not resulted in any material benefit to navigation. On January 15, 1888, Lieut. H. E. Waterman, Corps of Engineers, submitted a report (Exhibit No. 7) to Lieut. Col. J. W. Barlow, Corps of Engineers, then in charge of the improvement, in which he advised the abandonment of the greater part of the channel already excavated and recommended the excavation of a new channel along the left bank, involving the excavation of 66,000 cubic yards of solid rock. In 1891-92, a survey of the chute was made by Mr. W. G. Williamson, assistant engineer, under the direction of Capt. George W. Goethals, Corps of Engineers. Mr. Williamson's maps show an available depth in the improved channel, at low water, of only 1.4 feet at several places.

In his report to Captain Goethals, Exhibit No. 8, Mr. Williamson outlined plans for a channel 150 feet wide and of excellent alignment throughout the chute. For a depth of 6 feet at low water he estimated that it would be necessary to excavate 500,000 cubic yards of rock and gravel—and for a depth of 4 feet about 250,000 cubic yards of rock and gravel—to carry out his plans. Mr. Williamson also submitted plans for a lock similar to Lock A, and a dam at Miltons Bluff, about 1¼ miles above Lock A. The dam was to be connected with the lower end of Browns Island, and to be sufficiently high to insure a depth of at least 5 feet in the chute at extreme low water. He estimated the cost of executing this plan at $551,562.50. Nothing has since been done toward the improvement of this chute, which is now practically in the same condition as at the time of the last survey in 1891-92. At low stages entrance to the canal from above is impossible for boats drawing more than 15 inches, and at high stages navigation is attended with some danger on account of the high velocity of current and the narrowness of the outlined channels, and their improper location with reference to the general direction of flow. These difficulties emphasize the necessity for a radical improvement in this vicinity, and the following plan has been elaborated under your direction:

Proposed improvement.—A very careful study of the whole situation indicates quite clearly that the improvement of this chute, so as to realize a depth of not less than 5 feet at normal low water, can best be effected by raising the low-water level throughout the chute to a sufficient extent to accomplish the desired end. This can be done without doubt by tightening the present dam between the foot of Browns Island and Lock A, and by the construction of a suitable dam in the right chute near the head of the island, designed to prevent the water backed up by the lower dam from running around the island, and to force a sufficient flow into the left chute at low water to compensate for leakage through the lower dam and for the water used at Lock A. It has been assumed in designing these works that the upper end of the Muscle Shoals Canal is at the angle in the dam, about 2 miles above Lock A, and that any changes in the lock or in the embankment below this point, made necessary by raising the water level, will be undertaken in connection with the improvement or maintenance of the canal. As a matter of fact, the War Department has already made a ruling to this effect in passing on your project of October 30, 1900, for the improvement of the approach to Lock A.

Beginning, therefore, at the angle in the dam it is proposed to build it up to elevation 489.5 of the Williamson survey, which equals elevation 543.8 of the Hall survey, and to make it reasonably tight by means of a heavy gravel fill along its upstream side. The top or coping course of the dam, which will form the spillway for floods and surplus water, may be composed of concrete or of large, roughly scabbled stones, so laid as to present a reasonably smooth surface, and of sufficient size to remain in place under all ordinary conditions by reason of their weight alone.

Near the head of Browns Island, in the right chute, it is proposed to build a riprap dam of such height and tightness that the desired level in the left chute can easily be maintained during low stages. In order to decrease the height and cost of this dam, and at the same time to reduce as much as possible its effect in forcing the drift to the left chute at high stages, it has been located about two-thirds of a mile below the head of the island.

The cost of the work outlined above, which is shown on plate No. 6 herewith, is estimated as follows:

Repairing dam from foot of Browns Island:	
2,500 cubic yards of riprap dams, at $1	$2,500
6,000 cubic yards gravel and spalls for tightening dams, at 50 cents	3,000
1,500 cubic yards scabbled coping in place, at $6	9,000
Dam at head of Browns Island:	
8,000 cubic yards riprap dam, at $1	8,000
4,000 cubic yards gravel for tightening, at 50 cents	2,000
Total	24,500

It is not possible to foretell, without special study, just what the effect of the execution of this plan will be on the upper division of the canal and on Lock A. The flood flow in the left chute will doubtless be augmented, but at the same time the crest of the lower dam or overflow will be put in better condition to carry it. It is seen by the map and profile herewith that the dam above and below the angle, for a total length of 2 miles, will have about the same crest elevation, and consequently provides an overflow of such length that even a large increase in the flow of the chute would produce little increase in the mean depth on the crest. Consequently, it is not unreasonable to assume that no material change will result at Lock A. However, in order to illustrate the effect at Lock A of a decided increase in the elevation of the water surface during unusual floods, it will be admitted that an increase of 4 feet over the height attained during the great flood of 1897 is possible. In 1897 the river was within three-tenths of a foot of the top of the main walls at Lock A; hence, in order to provide against a further rise of 4 feet, it will be necessary to raise these walls about 4 feet, and to correspondingly strengthen the walls and modify the gates. It will be necessary in any event to provide much better facilities for taking care of the probable increase in the quantity of drift which will follow this channel. This can undoubtedly be done with greater satisfaction and safety than at present by the use of a suitable boom and a sufficiently large drift sluice. A very careful consideration of these questions shows that every contingency can be provided for at a cost of not exceeding $50,000.

The effect of the proposed works on the river above Browns Island will be in every way beneficial. The low-water level at the head of the island will be raised 3 feet over that adopted by Mr. Hall for the extreme low-water level, and a pool will be formed which, without allowance for surface slope—now amounting to 2 feet at low water—will extend to the foot of Limestone Bar, 16 miles above Browns Island. In this pool the channel depth at extreme low water will not be less than 4 feet, and generally much more. It is not possible to say what the surface slope will be at normal low water, but it is certain that it will be sufficient to considerably increase the channel depth over that assumed on the upper part of the reach affected by the works at Browns Island.

No. 2. Byrds Island Bar (*163.8 miles below Chattanooga*).—This bar is at the upper end of the left chute at Byrds Island. The available depth at extreme low water is 2.2 feet, and the length between 3-foot contours is 1,650 feet. At normal low water the depth will be fully 3 feet, and the length between 5-foot contours 2,100 feet. The fall is slight and uniform.

Proposed improvement.—The works at Browns Island will, without allowance for surface slope, give a water-surface elevation here of 543.8 feet, and since this obstruction is 7 miles above the head of Browns Island, it appears perfectly safe to assume that a surface elevation of at least 544 feet will be had at normal low water. For this surface elevation the available depth will be about 4.2 feet. It is consequently proposed to excavate a channel through this bar that will afford a depth of at least 5 feet over a width of 100 feet. The estimated cost of this work is as follows:

7,000 cubic yards gravel excavation, at 25 cents	$1,750

No. 3. Heintz Bar (*161.8 miles below Chattanooga*).—According to the Hall survey, this bar now affords full 3 feet at extreme low water. At normal low water the available depth will be nearly 4 feet, and this length, included between 5-foot contours, 4,500 feet. The slope is uniform and less than the mean for the middle section.

The works at Browns Island will doubtless result in a surface elevation here of 544 feet or more at normal low water, and give full 5 feet over a suitable width without additional work or cost.

No. 4. South Flint River Bar (*155.9 miles below Chattanooga*).—The Hall survey shows the available channel depth at extreme low water to be 2 feet, and the length between 3-foot contours to be 1,600 feet. At normal low water the depth will be nearly 3 feet, and the length between 5-foot contours 2,300 feet. The corresponding fall is 0.15 foot, giving a mean of 0.33 foot per mile.

Proposed improvement.—The works at Browns Island, 20 miles below, will doubtless result in a normal low-water surface elevation in this vicinity of at least 544.5 feet, and give a channel depth of more than 4 feet. In order to provide the channel dimension adopted for the present improvement, it is proposed to dredge a channel through the bar, estimated to cost as follows:

12,000 cubic yards gravel excavation, at 25 cents	$3,000

No. 5. Limestone Bar.—The river is shoal and wide in this vicinity for fully 3 miles. The fall is uniform and amounts to 1.40 feet, or 0.47 foot per mile. The obstruction is due to two bars separated by a shallow pool about 1 mile in length.

Lower bar (*153.9 miles below Chattanooga*).—This bar affords 2 feet at extreme low water, and has a length of 2,800 feet between 3-foot contours. At normal low water the channel depth will be nearly 3 feet, and the length between 5-foot contours 6,000 feet. The slope is quite uniform and amounts to 0.65 foot per mile. The bottom is generally rock.

Upper bar (*152.1 miles below Chattanooga*).—The least depth here at extreme low water is 2.3 feet, and the length between 3-foot contours 750 feet. At normal low water the depth will be nearly 3.3 feet, and the length between 5-foot contours 4,200 feet. The fall corresponding to this length is 0.28 foot, and the rate per mile 0.35 foot. The bottom is gravel.

Historical.—This locality was examined in 1868 by Mr. Gaw, and is described in his report (Exhibit No. 3). He estimated the cost of an improvement by excavation alone, designed to give a channel depth of at least 3 feet, at $7,500. In 1871 bids were solicited for doing this work in accordance with his plans, but, owing to lack of funds, nothing was done at that time.

In 1876 Mr. Paul Le Hardy, assistant engineer, examined these shoals, and in his report to Capt. W. R. King, Corps of Engineers (Exhibit No. 6a), describes them fully, and suggests an improvement designed to give a channel depth 3 feet at extreme low water by means of longitudinal dams, estimated to cost $20,000.

During the summer of 1900 the small party operating under your direction removed with a derrick boat about 350 cubic yards of rock and bowlders from the channel in this vicinity, which, according to Captain Thompson, in charge of the party, resulted in a channel 150 feet wide and fully 2.5 feet deep at extreme low water.

Proposed improvement.—The plan now proposed, which is intended to provide a channel of standard dimensions at normal low water, is as follows: The profile indicates the desirability of increasing the fall at the lower bar and raising the water-surface level over the remaining portion of these shoals. A bottom slope of 2 feet per mile is also indicated as the best for the contracted channel. It is therefore proposed to adopt this slope and to produce it in a regulated channel along the right bank by first excavating the bottom to this slope over a width of 100 feet, and then by suitably contracting the waterway by spurs from the left bank to make the normal low-water surface parallel to the general slope of the bottom, and not less than 5 feet above it.

The width of this channel is determined as follows: From fig. 5, pl. No. 4, the normal low-water flow 155 miles below Chattanooga is seen to be 9,700 cubic feet per second. The maps indicate that the mean depth of the resulting channel will be about 4 feet. For these conditions, and a slope of 2 feet per mile, the width per 1,000 cubic foot-second of discharge is found from Table No. 14 to be 94 feet, giving 911 feet as the width required for a flow of 9,700 cubic foot-seconds. The works to accomplish this are shown on plate No. 7, herewith. It is probable that near the upper end of the regulated channel it will be necessary to either reduce the depth by means of sills, or the width by increasing the length of the spurs. The former method has been adopted and used in estimating the cost, although in practice the latter method may be found the best. It is thought that these works will raise the normal low-water level immediately above them fully 2 feet, or to elevation 546.

The estimated cost of executing this plan is as follows:

15,000 cubic yards rock and gravel excavation, at $1	$15,000
24,000 cubic yards riprap dams, at 75 cents	18,000
	33,000

Allowance is made in the above estimate for the excavated materials used in constructing the dams.

The effect of these works will be to increase the depth at the upper bar to nearly 5 feet, and thus enable the improvement of this bar by means of dredging alone, at a comparatively small cost, estimated as follows:

4,000 cubic yards gravel excavation, at 25 cents	$1,000

No. 6. Gillsport Bar (*148.8 miles below Chattanooga*).—This bar is located about 1 mile above Bracks Branch, and is composed of projecting reefs and lumps scattered throughout the river bed, which cause steamboats to change their course from the right to the left bank in passing the bar. The maps show an available depth of 2.1 feet at extreme low water, with a length of 1,400 feet between 3-foot contours. At normal low water the depth will be about 3 feet and the length between 5-foot contours 2,200 feet. The fall is slight and but little in excess of the normal. The bottom is mainly gravel, with occasional rock reefs and bowlders.

Historical.—The journal of the survey of 1875 (Exhibit No. 5) shows that this obstruction then existed, and that a depth of 20 inches was available at low water. Reference is also made to a bar at the mouth of Bracks Branch, but it is said to afford more than 3 feet. The survey of 1899 does not show any obstruction at Bracks Bar, although the working party in the field in 1900 removed 55 cubic yards from the reefs in this vicinity and reports the available depth at 2.5 feet. These discrepancies are probably due to the survey missing the detached reefs and lumps. It is intended in the present estimate to make a general provision for such cases, and to provide, under a separate head, for the cost of clearing the channel of detached obstructions.

Proposed improvement.—Returning to Gillsport Bar, it is proposed to provide a suitable channel along the right bank by dredging. This is estimated to cost as follows:

8,000 cubic yards gravel, stone, and bowlders, at 50 cents	$4,000

No. 7. Triana Bar (*143.5 miles below Chattanooga*).

No. 8. Indian Creek Bar (*142.8 miles below Chattanooga*).

These two obstructions are practically one, and will be so treated in discussing their improvement. The river is unusually wide in this vicinity (1,600 feet), and the obstructions are caused by gravel bars and occasional rock reefs. Triana Bar now affords fully 3 feet at extreme low water. At normal low water a depth of not less than 4 feet exists, and the length between 5-foot contours is 3,100 feet. The fall is but 0.10 foot, and uniformly distributed.

Indian Creek Bar is separated from Triana Bar by a short pool. At extreme low water the channel depth is not less than 2.1 feet, and the length between 3-foot contours, 1,250 feet. At normal low water the least channel depth is about 3 feet, and the length between 5-foot contours, 1,600 feet. The total fall is 0.40 foot, giving a mean of 1.3 feet per mile.

Historical.—Mr. Williamson found, by inquiry among the river pilots in 1875, that the depth at this bar was reduced to 22 inches at extreme low water. Although none of the other early reports make specific mention of this obstruction, it has always been known to steamboat men.

Proposed improvement.—An examination of the general maps and profile shows that by raising the normal low-water level at the head of Indian Creek Bar to elevation 547.6, that the required normal channel dimensions will result as far as Burdine Bar, 8 miles above. This result will justify the execution of the extensive works which it is proposed to locate at Triana Bar.

A bottom slope of 1 foot per mile, and a mean depth of 4.5 feet, appears from the map and profile to be best suited to the locality. The normal low-water flow is 9,600 cubic feet per second. The channel width corresponding to these conditions is found from Table No. 14 to be 1,056 feet. A channel of this width on the right bank will be outlined by spurs from the left, as shown on plate No. 7, herewith. The normal level below the works is taken at elevation 546.6, which allows for an increase of 0.5 foot over that assumed to result from the works at Limestone Bar. The normal level above will be 547.6, making the length of the regulated channel 1 mile.

The cost of the works described and shown on the drawings is estimated as follows:

25,000 cubic yards gravel, rock, and bowlders, at 40 cents	$10,000
25,000 cubic yards riprap dams, at 75 cents	18,750
	28,750

In practice it may be found better to produce the spurs than to attempt to reduce the section by sills, as contemplated above. In either case the quantities of material and cost will be about the same.

No. 9. Lees Bar (139.9 miles below Chattanooga).—This bar is in Lewis Bend, about 1 mile below the Lewis Ferry. It is composed of gravel, and forces the low-water channel to left bank. The available depth at extreme low water in the steamboat channel is 2 feet, and the length between 3-foot contours 800 feet. At normal low water the channel depth will be nearly 3 feet, and the length between 5-foot contours 1,000 feet. The bar produces no unusual slope disturbance at low stages.

The survey indicates that for the normal low-water surface level produced by the works at Triana a channel not less than 5 feet deep will be found about 400 feet out from the left bank. It is thought, however, that this route is more or less obstructed by lump and detached obstructions. These it is proposed to remove at the following estimated cost:

2,000 cubic yards rock and bowlders, at $1	$2,000

No. 10. Burdine Bar (131.1 miles below Chattanooga).—This obstruction is quite generally known among river men as "Bird Iron" Bar, but as there seems to be no doubt that this is due to a mispronunciation of its true name, it will be designated as "Burdine Bar" in the present report.

The obstruction is due to gravel lumps and rock reefs scattered promiscuously over the river bed for a length of about a mile. The steamboat channel follows the right bank. The available depth at extreme low water is 2 feet, and the length between 3-foot contours 1,400 feet. The fall is 0.5 foot, and the rate 1.95 feet per mile. At normal low water the depth will be about 2.8 feet, the length between 5-foot contours 2,200 feet, the fall 0.7 foot, and the rate of fall 1.8 feet per mile.

Historical.—In his report of July, 1868 (Exhibit No. 3), Mr. Gaw designates the reach extending from what is now known as Hobbs Island to the foot of Burdine Bar, as "Whitesburg Shoals and Reefs." He gives the available channel depth at low water at 2 feet, and suggests an improvement of the various shoal places or bars so as to give a depth of at least 3 feet by means of wing dams at each bar in the Hobbs Island Chute and by channel excavations at the two bars or reefs below the island. He estimates the cost of this work at $5,768.50.

In 1875 Mr. Williamson found, from inquiry among pilots and others familiar with the river, that a depth of not exceeding 20 inches was available at extreme low water over this reach.

In 1876 Mr. Le Hardy examined this locality, and states in his report (Exhibit No. 6a) that the low-water depth is not less than 2 feet. The improvement suggested by him—designed to secure a low-water depth of 4 feet—consists of a wing dam 600 feet long, near the foot of Hobbs Island (Chunns Bar), estimated to cost $6,000. At Whitesburg Shoals he proposed two wing dams from opposite shores, with a total length of 1,500 feet, estimated to cost $15,000.

No work of importance has ever been undertaken on this reach, but in 1900 Captain Thompson, acting under your directions, removed a number of bowlders and loose rock from the channel at Burdine Bar, and reports (Exhibit No. 12) that 3 feet at extreme low water is easily attainable by the removal of a number of detached bowlders.

Proposed improvement.—The profile indicates that an excavation through Burdine Bar, to a depth of 5 feet below normal low water, would entail a large amount of work and would probably be followed by unfavorable results at the shoals above. It consequently appears best to improve Burdine Bar by contraction, combined with the excavation necessary to produce required normal low-water conditions, and at the same time so raise the water surface above the bar, so as to either wipe out the obstructions at Whitesburg and Chunns bars or to materially reduce the work necessary to accomplish this. The natural shape and conditions at the bar indicate the advisability and economy of a slope of 3 feet per mile, and a mean depth of 4 feet. The normal low-water level below the bar is elevation 548.6, and the desirable level above the bar is elevation 551. The fall to be overcome is 2.5 feet, requiring for the adopted slope a regulated length of channel of 4,300 feet. At this locality the normal low-water flow is 9,500 cubic feet per second, and the width of channel corresponding to the conditions given is found by Table No. 14 to be 722 feet.

It is proposed to outline this channel by means of the works shown on the accompanying drawing, consisting of spurs from the left bank, with sills and channel excavation wherever necessary. As will be seen later, these works will have a very favorable effect in reducing the succeeding obstacles as far as Paint Rock Shoals, 12.5 miles above.

The cost of the works above described and shown on plate No. 9 is estimated as follows, allowing for excavated material used in dams:

30,000 cubic yards gravel and loose rock excavation, at 30 cents	$9,000
30,000 cubic yards riprap dams, at 75 cents	22,500
	31,500

No. 11. Whitesburg Bar (130.7 miles below Chattanooga).—This bar is found opposite Whitesburg Landing. It is composed of gravel and rock reefs and now affords 3 feet at extreme low water. At normal low water the available depth will be 4 feet and the length between 5-foot contours 400 feet. The fall is slight and uniform.

The works at Burdine Bar will doubtless result in a normal low-water depth of full 5 feet at this bar without additional work or expense.

No. 12. Chunns Bar (129.4 miles below Chattanooga).—This bar is in the left chute near the foot of Hobbs Island. The obstruction is due to rock reefs and gravel lumps, which interfere with navigation at low stages.

According to Mr. Hall's survey, the available depth at extreme low water is 2.8 feet, the length between 3-foot contours 200 feet, and the fall slight. At normal low water the depth will be about 3.7 feet, the length between 5-foot contours 600 feet, the fall 0.12 foot, and the rate of fall 0.75 foot per mile. The probable normal low-water surface level, resulting from the works at Burdine Bar, will materially decrease the difficulties here and enable a desirable improvement by dredging at a cost estimated as follows:

4,000 cubic yards gravel and loose rock, at 40 cents	$1,600

No. 13. Flint River Bar (124.8 miles below Chattanooga).—This obstacle to low-water navigation is opposite and below the mouth of Flint River, between Flint River Towhead and the right bank. The towhead is a low flat gravel bar about 1,000 feet wide and 2,600 feet long at low water. It reduces the right chute used by steamboats to a width of 400 feet, and the left chute to a width of about 150 feet. The steamboat channel follows down the right bank, although the maps indicate a better channel by going over to the left bank after passing the foot of the towhead. This route must, however, be occupied by detached obstructions or it would not have been necessary to do the work about one-half mile below Flint River, near the right bank, hereafter referred to. This bar, as shown by the survey, affords a depth of 2.8 feet at extreme low water with a length of 600 feet between 3-foot contours, and fall of 0.5 foot, or 4.5 feet per mile. At normal low water the depth will be 3.5 feet, the length between 5-foot contours 1,200 feet, and the fall 0.6 foot, or 2.7 feet per mile. The bottom is composed of gravel and bowlders with occasional projecting reefs.

The examination made in 1867 developed a different condition from that now indicated. Mr. Gaw, in his report, refers to two bars below the foot of the towhead, and states that the steamboat channel passes between them in going from the right to the left bank. The depth in the channel between these bars is given at 2.5 inches. Over what is now designated as the Flint River Bar he found a low-water depth of 3.5 feet. His plan for an improvement was to connect the two bars mentioned by a dam, and thus keep the channel down the right bank and increase the depth from 20 inches, then existing in the proposed channel, to sufficient for the needs of commerce. This work he estimated to cost $799.50. The above is practically the only instance met with where a material change in the regimen of the bed of the river, due to natural causes, has been shown by a comparison between the former and present surveys. The bars referred to by Mr. Gaw do not appear on the late maps, and it is probable that they were due to deposits carried out by the Flint River, which were washed away by some succeeding flood in either the Tennessee or Flint River.

The journal of Mr. Williamson's examination in 1875 reports an available depth in the channel along the right bank of only 16 inches, which is another evidence of the instability of this particular locality.

In 1877 Mr. Le Hardy reported that the removal of two snags, at a cost of $50, would make available a low-water depth of 4 feet at this obstruction.

In 1894 this bar was surveyed by Mr. W. G. Walker, assistant engineer, under direction of Capt. George W. Goethals, Corps of Engineers. In his report (Exhibit No. 11b) Mr. Walker gives the available low-water depth as 2 feet, and recommends the opening of the left chute—which, according to his information, had formerly been used by steamboats—at an estimated cost of $2,942.50.

In 1896 the U. S. dredge *Harwood* removed 95 cubic yards of bowlders and 2,900 cubic yards of gravel from the bar near the right bank one-half mile below the mouth of Flint River, at a cost of $785.53. About one-half of the work considered necessary to give a depth of 3 feet was done at that time. During the succeeding year several reefs were removed and sufficient work done to give a channel at the lower bar 3 feet deep and from 60 to 150 feet wide.

Proposed improvement.—The reach between the head of Hobbs Island and Guntersville is now and has been for years used more extensively for navigation purposes than any other equal length of river above the Muscle Shoals. It is consequently desirable that its improvement should be designed to give the greatest practicable satisfaction to navigation interests. To this end it is proposed to excavate an ample channel through Flint River Bar, and thus materially decrease the low-water fall there and carry the pool formed by the works at Burdine Bar as far upstream as possible.

The slacking of the current opposite the mouth of Flint River may result in the formation of objectionable deposits. In this event it will be necessary to resort to dredging to maintain the desired channel depth and width.

The probable normal surface elevation at the head of Burdine Bar was 551 feet, but, owing to the long and deep intervening pool, it does not seem safe to calculate on an increase of more than 0.2 foot at Flint River Bar. For this surface elevation the cost of a suitable channel down the right bank is estimated as follows:

25,000 cubic yards gravel and bowlder excavation, at 30 cents $7,500

A channel crossing over to the left bank and following the somewhat circuitous route shown on the map could probably be provided for about two-thirds the cost above given.

No. 14. Allens Bar (*117.9 miles below Chattanooga*).—This bar is referred to in some of the early reports as Paint Rock Bar—probably on account of the proximity of Paint Rock Bluff. According to Mr. Hall, the depth available at extreme low water is 2.8 feet, and the length between 3-foot contours 450 feet. At normal low water the depth will be about 3.7 feet, and the length between 5-foot contours 3,200 feet. The fall is 0.4 foot, and the mean rate 0.7 foot per mile. The bar is composed of gravel and bowlders.

Historical.—The report of 1868 makes no mention of this obstruction, and Mr. Williamson's journal gives the low-water depth as 24 inches. In 1894 this locality was surveyed by Mr. J. W. Walker, assistant engineer. In his report to Capt. John Biddle, Corps of Engineers (Exhibit No. 11b), Mr. Walker states that this obstruction is caused by three distinct ridges nearly perpendicular to the current, where dredging will be necessary to secure 4 feet. He also proposes two check dams about 600 feet long to maintain the dredged channel. The cost of this work is estimated at $9,121.20.

Proposed improvement.—At the present time, in view of the probable normal level produced by the works at Burdine Bar, 12½ miles below, which, on account of the very long and deep intervening pools, is taken at elevation 551.5; in view of the desirability of reducing, as far as possible, the number of places where contraction works are used, and in view of the difficulty, on account of the shortness of this bar, of gaining much elevation at it by contraction, it is proposed to simply dredge a channel of suitable dimensions through the bar and to depend on the works at the next shoal above for raising the normal level.

The cost of this excavation, which, according to the maps, is all in gravel, is estimated as follows:

30,000 cubic yards gravel excavation, at 25 cents	$7,500

No. 15. Coles Bend Bar (115.7 miles below Chattanooga).—This obstruction is sometimes called Speers Bar, on account of its proximity to Speers Landing. The steamboat channel follows the right bank, although the maps indicate better and deeper routes along the left bank. It is probable, however, that beyond the limits of the present steamboat track the river bed is more or less obstructed by gravel lumps and detached reefs and bowlders, and not passable at low water. The available channel depth at extreme low water is 2.8 feet, with a length of 800 feet between 3-foot contours. At normal low water the obstruction consists of two bars, separated by a shallow pool, about 2,000 feet long. The available depth will be about 3.6 feet, the length between 5-foot contours 3,700 feet, the fall 0.66 foot, and the rate 0.95 foot per mile.

Historical.—The early reports did not recognize this bar as an obstruction to low-water navigation.

In 1894 it was surveyed by Mr. J. W. Walker, assistant engineer, who reported to Capt. John Biddle, Corps of Engineers, under date of October 24, 1894 (Exhibit No. 11c), that the obstruction consisted of two gravel bars, on which the depth at low water was 2.8 feet. He suggested an improvement by dredging, supplemented by two spur dams, designed to give a depth of at least 4 feet. The cost of this work was estimated at $10,854.25.

Proposed improvement.—The length of the bar (5,700 feet from out to out between 5-foot contours at normal low water), and the comparatively narrow width of the river (1,200 feet), make this a desirable location for works designed to raise and maintain the level of the pool extending to Beards Reef, 7 miles above. The normal low-water elevation of the water surface below this bar is assumed to be 551.5, although it is probable that this elevation will be exceeded.

A careful consideration of all the conditions indicates the desirability and economy of a regulated channel, about 6,100 feet in length along the left bank, having a surface slope of 2 feet per mile and a mean depth of 4 feet. The normal low-water discharge for this locality is 9,350 cubic feet per second, giving 879 feet as the mean width for the regulated channel. As shown on the accompanying drawings (pl. No. 10), this channel is to be outlined by spurs from the right bank by sills or submerged dams, and by the excavation necessary to give the required normal channel dimensions. It is anticipated that these works will give a surface elevation of at least 553.8 immediately above them, and in all probability an elevation of 554 at Beards Reef.

While sills have been used in the estimate and shown on the drawings, it is possible in this case, as in all similar ones, that experience may show the desirability of extending the spurs and not using sills except where the depth is excessive, or the bottom shows signs of being unstable.

The cost of the works described, making some allowance for the use of excavated materials in building dams, is as follows:

35,000 cubic yards gravel and loose rock excavation, at 40 cents	$14,000
28,000 cubic yards riprap dams, at 75 cents	21,000
	35,000

The maximum velocity in this channel, according to Table No. 14, will be about 3.65 feet per second. This considered in connection with the known resistance of the banks leads to the conclusion that no protection will be required on the left bank.

No. 16. Browns Bar (109 miles below Chattanooga).

No. 17. Beards Reef (108.4 miles below Chattanooga).

No. 18. Beards Bar (107.2 miles below Chattanooga).

These obstructions, although known locally under the designations given, are so close together that they form a continuous obstacle to low-water navigation, and will accordingly be treated under one head.

At Browns Bar the available depth at extreme low water is 2.4 feet; the length between 3-foot contours, 400 feet; the fall, 0.4 foot, and the rate of fall, 5.25 feet per mile. At normal low water the available depth will be about 3 feet; the length between 5-foot contours, 850 feet; the fall, 0.33 foot, and the rate of fall, 2.1 feet per mile.

At Beards Reef the available depth at extreme low water is 2.4 feet; the length between 3-foot contours, 350 feet; the fall, 0.4 foot, and the rate of fall, 5.3 feet per mile. At normal low water the depth will be about 3.2 feet; the length between 5-foot contours, 600 feet; the fall, 0.4 foot, and the rate of fall, 3.5 feet per mile.

At Beards Bar the available depth at extreme low water is 2.4 feet; the length between 3-foot contours, 4,900 feet; the fall, 0.6 foot, and the rate of fall, 0.65 foot per mile. At normal low water the available depth will be 3.2 feet; the length between 5-foot contours, 6,000 feet; the fall, 0.7 foot, and the rate of fall, 0.58 foot per mile.

The survey shows that these bars are composed mainly of gravel, with scattered reefs and bowlders. Considered as a whole, the available depth at normal low water will be about 3 feet; the length between 5-foot contours, 10,800 feet; the fall, 2.3 feet, and the mean rate of fall, 1.65 feet per mile.

Historical.—The report of the examination made in 1867 refers to these obstructions as Gunters Reef, and gives the available depth at 2 feet. An improvement by excavating through the main or Beards Reef, at a cost of $750, was recommended (Exhibit No. 3). The journal of the survey of 1875 (Exhibit No. 5) refers to Browns Reef as Beards Creek Bar, but gives no particulars concerning it. At Beards Reef, or Gunters Reef No. 2 as he designates it, Mr. Williamson reports an available depth of 18 inches. In his report of June 29, 1877, Mr. Le Hardy suggests the construction of a wing dam nearly across the stream just below Beards Reef with a second dam below "to prevent the water thus gained being lost." He estimates the cost of these dams at $15,000. In October, 1892, an examination of Beards Reef was made under the direction of Captain Goethals, and followed up by the removal of about 30 cubic yards of rock, which is reported to have given a channel 120 feet wide by 3 feet deep (Exhibit No. 10).

In 1894 a detailed survey was made of Beards Reef by Assistant Engineer Walker. In his report to Captain Biddle (Exhibit No. 11a), Mr. Walker recommends the construction of a cross dam from the left bank on the reef itself to reduce the width of the waterway to between 300 and 400 feet. This dam was to be supplemented, if necessary, by a check dam below it. The cost of the main dam was estimated at $8,905.

In the fall of 1896 the channel at Beards Reef was dredged to a width of 120 feet, and a depth of 3 feet for a length of 500 feet. This work involved the removal of 9,385 cubic yards of gravel, loose rock, and bowlders at a cost of 21 cents per cubic yard; and 190 cubic yards of solid rock at a cost of $1.44 per cubic yard (Exhibit No. 10).

Proposed improvement.—The proximity of Gunters Reef and Bar makes it desirable to raise, or at least maintain, the normal level in the Guntersville pool, and on account of the commercial importance of the reach below Guntersville the best slope, width, and depth, consistent with the existing conditions, should be adopted. With these considerations and the naturally favorable location for contraction works in view, it appears best to provide a regulated channel along the left bank, extending upstream 1 mile from the foot of Browns Bar, designed to raise the normal low-water surface from elevation 554 below the bar to elevation 556 above it. The surface slope is accordingly made 2 feet per mile; the mean depth will be about 4.5 feet; and the width, for a discharge of 9,300 cubic feet per second, 725 feet. This channel is outlined by means of spurs along the right bank, assisted by suitable sills and channel excavation where necessary.

These works, which are clearly indicated on the drawings herewith (pl. No. 10), are estimated to cost as follows:

20,000 cubic yards gravel, rock, and bowlder excavation, at 40 cents	$8,000
25,000 cubic yards riprap dams, at 75 cents	18,750
	26,750

No. 19. Gunters Reef and Bar (105.4 miles below Chattanooga).

No. 20. Henrys Bar (103.2 miles below Chattanooga).

These two obstructions to low-water navigation are found in the steamboat or right chute at Henrys Island. Although separated by a short and comparatively shallow pool, they have usually been considered and discussed together.

Gunters Reef or Bar, as it is sometimes called, lies between Henrys and McKees islands. The maps show the available low-water channel depth to be 2.1 feet, the length between 3-foot contours 1,800 feet, the total fall 2.08 feet, the mean rate of fall 6.1 feet per mile, and the maximum rate of fall 9.5 feet per mile. At normal low water the available depth will be less than 3 feet, the length between 5-foot contours 2,400 feet, the fall 2.2 feet, and the mean rate of fall 4.75 feet per mile. The bottom is rock, with gravel between the reefs and in the deeper holes. Henrys Bar is located at and below the head of Henrys Island. It appears to be due to the presence of large bowlders and scattered reefs, and to deposits caused by Short Creek, which empties into the main river through the left chute around Henrys Island.

At extreme low water the available depth is 3.5 feet, in a narrow channel; the fall is 2 feet, the mean rate of fall 5.25 feet, and the maximum rate 8.5 feet per mile. The velocity of current is high and the passage difficult for ladened boats. At normal low water the depth will be about 4.2 feet, the fall 1.7 feet, and the mean rate of fall 4.5 feet per mile. The conditions are thus better than at extreme low water, but owing to the strength of the current and narrowness of channel, the passage is attended with difficulty, until a comparatively high stage is reached. The bottom is composed of rock, bowlders, and gravel.

Historical.—In 1867 the channel near the head of Town (Henrys) Island was found to be obstructed by numerous large bowlders, with a depth of but 20 inches available at extreme low water. The estimated cost of removing these obstructions so as to provide a channel depth of at least 3 feet was $57.50. At Gunters Bar but 10 inches was found at extreme low water, and it was estimated that a channel 3 feet deep and 100 feet wide could be cut through the reefs at a cost of $1,017.50 (Exhibit No. 3). Bids were taken for doing this work in 1871, but owing to lack of funds the improvement was not actually undertaken.

The inquiries instituted by Mr. Williamson in 1875 (Exhibit No. 5) gave a depth of 20 inches at the head of Henrys Island and 13 inches at Gunters Reef.

In 1891 the locality was carefully surveyed for the first time by Mr. D. L. Sublett, assistant engineer, under the direction of Capt. George W. Goethals, Corps of Engineers. In his report (Exhibit No. 9b) Mr. Sublett recommends the straightening of the channel at Gunters Reef by means of an excavation near the center of the river 150 feet long, 120 feet wide, and 3 feet deep at extreme low water, which he estimated to cost $4,103.25. In the project submitted by Captain Goethals (Exhibit No. 9a) he recommends the removal of bowlders from the channel above Gunters Reef and the excavation of the channel described above through the reef itself.

In 1892 a contract was entered into with Messrs. Neely & Smith for excavating this channel, but after the removal of 716 cubic yards they were obliged by high water to quit the work, and it was not again taken up until June, 1894, when, by authority of the Chief of Engineers, the contractors were allowed the use of the United States dredge *Harwood*. They soon found the excavation too heavy for this plant, and in November, 1894, abandoned their contract.

In August, 1895, the work was undertaken by hired labor, and during that working season 806 cubic yards of rock was removed, giving, according to reports, a channel 350 feet long, 60 feet wide, and 2.5 feet deep at low water.

In 1896 the channel was widened at the head of Henrys Island by the removal of several small bowlders. In 1900 this section was further improved by the removal of 45 cubic yards of rock reefs, giving, according to the report of Captain Thompson (Exhibit No. 12), a channel 100 feet wide and 3 feet deep at extreme low water.

Effect of work done.—For the purpose of determining the approximate effect of the work heretofore done, an attempt has been made to compare the surveys of 1891, 1894, and 1899, but in the absence of direct connection between the bench marks of these surveys the result has not been entirely satisfactory. The survey of 1891, which was made while the stage was about 5 feet higher than during the survey of 1899, shows a fall of 0.4 foot in 500 feet, or 4.4 feet per mile, at Gunters Reef, as compared with a fall of 1.8 feet in 1,100 feet, or 8.7 feet per mile, observed by Mr. Hall in 1899. In 1894, for a stage 3 feet higher than during the Hall survey, Mr. Winn found a fall of 0.3 foot in 200, or 8 feet per mile.

From a comparison of the various profiles at Gunters Reef and Henrys Bar, the conclusion is reached that the excavation done has materially lowered the low-water surface level at and above the reefs, and has consequently increased the fall and difficulties at the head of Henrys Island. The evidence at hand makes it appear that this lowering has amounted to from 1.5 to 2 feet at Gunters Reef, and to about 1 foot in the pool above the island.

The total field cost of the work heretofore done on this reach and at Beards Reef and Flint River Bar is $12,000.

Proposed improvement.—Gunters Reef offers a more serious obstacle to free and unimpeded low-water navigation than any of the obstructions heretofore considered, and its improvement will prove relatively more difficult and expensive. The profile shows that it will be necessary to overcome a fall of about 2.6 feet in a distance of about 3,500 feet, which will require a slope of 4 feet per mile in the regulated channel. The maximum velocity corresponding to this slope and a mean depth of 4 feet is seen by Table No. 14 to be 5.16 feet. This is greater than desired, but since any less mean depth can not be easily realized, and any less slope will greatly increase the cost of the works, it seems desirable to adopt the slope and depth given. Two general plans are open for the regulation of a shoal of this nature, viz, (1) by regulating the channel with reference to the whole normal low-water flow in the manner indicated for the preceding obstruction; (2) by excavating a canal in the bed of the river designed to give a predetermined depth, width, and slope, and separated from the main stream by means of longitudinal dams of sufficient height to prevent an overflow into the regulated channel until the obstructions in the natural channel are drowned out and the water-surface slope becomes practically uniform throughout the entire bed. This is the method adopted and successfully carried out for the improvement of most of the cataracts of the Danube.

The first method would doubtless give the most satisfactory improvement; but when we consider the expense necessary to carry this plan into effect and to provide a channel through solid rock having a mean depth of 4 feet and a mean width of 625 feet at normal low water, we are led to look to some other less expensive means of overcoming the difficulty. The second method mentioned offers a less expensive solution of the problem, and will be followed in designing the improvement.

From a study of the situation it has been decided to propose a channel, following the left bank, of such width and shape that it will provide a maximum depth of 5 feet over a width of 100 feet, with a mean depth for the whole channel of 4 feet. This channel will be separated from the main river by a longitudinal dam so located as to give the desired dimension with the least amount of work. The exact location of the dam is a matter of importance, and will require a special survey before undertaking the work. It is probable, however, that it will be found best to run it practically parallel to the left bank, at a distance from it that will reduce the excavation to a minimum, and when the resulting mean depth is too great short submerged spurs or sills can be used to reduce the section. The height to which it will be necessary to build the longitudinal dam is a matter of some doubt, but from the surface slope given by the observation of 1894 it appears that the obstructions in the river bed were practically drowned out, and that fully 7 feet was then available in the main bed. The stage then existing was about 5 feet above extreme low water. It is consequently proposed to base the present estimates on building this dam up to 6 feet above low water.

The locations of the proposed channel and dam are shown on the accompanying map (plate No. 10). The cost is estimated as follows, including a riprap protection for the left bank:

30,000 cubic yards solid rock and gravel excavation, at $1	$30,000
20,000 cubic yards riprap dams, at 50 cents	10,000
	40,000

The works above described will not materially alter the normal low-water surface level in the pool above them, which is assumed to be elevation 588.8 at the head of Gunters Reef, and elevation 559 at the foot of Henrys Bar.

In order to back out the objectionable fall opposite the head of Henrys Island, it is proposed to so contract the channel below it as to produce a slope of 3 feet per mile, beginning 4,200 feet below the head of Henrys Island, and extending upstream to the head of the island. An examination of the maps indicates the economy of a mean depth of 4.5 feet, for which the channel width, corresponding to a slope of 3 feet per mile and a discharge of 9,300 cubic feet per second, is 595 feet. This channel will be outlined by the works shown on the drawings, consisting of spurs for the left bank, and of sills and excavation wherever necessary. The cost of the works shown is estimated as follows:

10,000 cubic yards of gravel and rock excavation, at 40 cents	$4,000
16,000 cubic yards of riprap dams, at 75 cents	12,000
	16,000

No. 21. Buck Island; lower bar (100.6 miles below Chattanooga), upper bar (99.1 miles below Chattanooga).

No. 22. Columbus Bar (98.1 miles below Chattanooga).

According to the survey these bars afford a channel depth of 3 feet at extreme low water and do not produce any particular disturbance in the slope. At normal low water the available depth on the lower bar will be about 4 feet, the length between 5-foot contours 3,000 feet, the fall 0.7 foot, and the rate of fall 1.2 feet per mile.

At the upper bar the depth will be about 4 feet, the length between 5-foot contours 7,000 feet, the fall 1.4 feet, and the rate of fall 1.05 feet per mile.

At Columbus Bar the available depth will also be about 4 feet, the length between

5-foot contours 800 feet, the fall 0.1 foot, and the rate of fall 0.65 foot per mile. The bottom is generally gravel, with scattered reefs and bowlders.

Historical.—In 1867 Mr. Gaw found only 20 inches in a channel along the left bank, about 1 mile above Buck Island. Between this point and the foot of the island he reports the existence at three localities of large masses of rock scattered about irregularly in the channel. He estimates the cost of an improvement by means of a wing dam at the upper shore and by removing the masses of rock referred to at $2,066.50.

In 1875 Mr. Williamson found by inquiry that 18 inches was available in the channel at extreme low water in this vicinity. Although no record is found of the removal of any of these obstructions, it appears certain, from the record of the recent survey, that some work must have been done at this locality.

Proposed improvement.—The plan now proposed is to maintain this reach in as near its present favorable condition at normal low water as may be found consistent with the requirements of the improvement. The natural slope at normal low water varies but little from 1 foot per mile. In order to maintain this slope with a flow of 9,200 cubic feet per second, and a maximum depth of 5 feet over a width of 100 feet in the steamboat channel, it will be necessary to compensate for any material excavation by spurs or sills. If the resulting mean depth is 4 feet, then the width should be 1,223 feet; if 4.5 feet, the width will be 1,012 feet. The latter conditions have been used in estimating the cost and locating the works on the accompanying map (pl. No. 11).

The cost of the works shown is estimated as follows:

40,000 cubic yards gravel excavation, at 25 cents	$10,000
40,000 cubic yards riprap dams, at 75 cents	30,000
	40,000

Allowance is made for using a large percentage of the excavated material in constructing the dams. A normal low-water depth of 4 feet can be provided on this reach at a comparatively small cost for dredging, which it is thought can be done without injury or lowering the water-surface level if care is taken to confine the dredging operations to the minimum consistent with the desired depth.

No. 23. Pine Island; lower bar (96.3 miles below Chattanooga), Gunters Bar (94.3 miles below Chattanooga), upper bar (93.2 miles below Chattanooga).—These obstructions are all in the right chute at Pine Island, and according to Mr. Hall's maps, consist of gravel bars on which the low-water depth is less than desired under the project now being considered. The total fall in the chute is 3.4 feet in 4 miles, giving a mean of 0.85 foot per mile. At the lower bar the available depth at extreme low water is 2.5 feet; the length between 3-foot contours, 600 feet; the fall, 0.2 foot; and the rate of fall 1.6 feet per mile. At normal low water the depth will be about 3.3 feet; the length between 5-foot contours, 3,700 feet; the fall, 0.9 foot; and the rate of fall, 1.32 feet per mile.

At Gunters Bar the depth is 3.4 feet at extreme low water. At normal low water the depth will be about 4.2 feet; the length between 5-foot contours, 1,100 feet; the fall, 0.26 foot; and the rate of fall 1.2 feet per mile.

At the upper bar the available depth at extreme low water is 2.5 feet; the length between 3-foot contours, 1,500 feet; the fall, 0.25 foot; and the rate of fall 0.90 foot per mile. At normal low water the depth will be about 3.3 feet; the length between 5-foot contours, 2,800 feet; the fall, 0.5 foot; and the rate of fall, 0.9 foot per mile.

Historical.—No mention is made of any of these bars in the early reports, and there is no record of any work ever having been done in this vicinity.

Proposed improvement.—By a comparatively small amount of dredging a channel depth of full 4 feet at normal low water can be secured through the navigable chute. In order, however, to bring about the limits now proposed it will be necessary to resort to both dredging and contraction.

At the lower bar the natural conditions indicate the feasibility and economy of a slope of 2 feet per mile and a mean depth of 4.5 feet, for which, and the normal low-water discharge (9,200 cubic feet per second), the channel width will be 717 feet. It is proposed to contract the channel for a distance of 4,800 feet to this width by spurs from the right bank, and thus raise the normal surface from elevation 565.4 at the foot of the bar to elevation 567.25 above it.

The cost of this work, which is shown on plate No. 11 herewith, is estimated as follows:

10,000 cubic yards gravel excavation, at 25 cents	$2,500
10,000 cubic yards riprap dams, at $1	10,000
	12,500

At Gunters Bar it is probable that some excavation will be required to produce a channel of standard dimensions. This is estimated as follows:

6,000 cubic yards gravel and rock excavation, at 40 cents	$2,400

At the upper bar the conditions are quite similar to those found at the lower bar, and the same remedy is proposed, namely, a contraction to a width of 717 feet by means of spurs from the island shore, designed to give a mean depth of 4.5 feet and a slope of 2 feet per mile at normal low water. The length of the contracted channel will be about one-half mile, and the normal water surface will be raised from elevation 568 below the bar to elevation 569 above it.

The works to accomplish this are clearly shown on the accompanying drawing (pl. No. 11), and are estimated to cost, including a dam across the left chute to confine the normal flow to right chute, as follows:

15,000 cubic yards gravel excavation, at 25 cents	$3,750
9,000 cubic yards riprap dams, at $1	9,000
	12,750

As was the case at the lower bar, a comparatively small amount of dredging, in connection with the closing of the left chute, will result in a 4-foot channel at this locality.

No. 24. Romans Bar (91.8 miles below Chattanooga).—This bar is situated just below Romans Landing and the mouth of South Sauty Creek, to which it is probably due. It is composed of gravel and bowlders, and now affords a depth of 2.5 feet at extreme low water, when the length between 3-foot contours is 500 feet, the fall 0.1 foot, and the rate of fall 1.1 feet per mile. At normal low water the available depth will be about 3.3 feet, the length between 5-foot contours 1,500 feet, the fall 0.3 foot, and the rate of fall 1.05 feet per mile.

Historical.—Mr. Williamson reported an available depth of 18 inches in 1875. Aside from this no mention has been made of this obstruction in any of the early reports, and no work has ever been done here.

Proposed improvement.—The necessity for at least maintaining the present normal level above this bar, on account of the proximity of Mink Creek Shoals above, makes it necessary to counteract the effect of any dredging done here by suitable contraction works. It is consequently proposed to dredge a channel of standard dimensions through the bar and to contract the channel by spurs from the left bank so as to produce a slope of 1 foot per mile and a mean depth of 4.5 feet for the normal flow of 9,200 cubic feet per second. The width of channel will be 1,012 feet.

The location and extent of the necessary works are shown on the accompanying drawings, and the cost is estimated as follows:

10,000 cubic yards gravel and loose rock, at 30 cents	$3,000
7,000 cubic yards riprap dams, at $1	7,000
	10,000

No. 25. Mink Creek or Swaffords Bar (88.8 miles below Chattanooga).

No. 26. Cross Bar (87.5 miles below Chattanooga).

These bars form practically one continuous obstacle at low stages. At extreme low water the available depth at Mink Creek Bar, in a very narrow channel, is 2.6 feet; the length between 3-foot coutours, 200 feet. The corresponding fall is very slight. At normal low water the available depth will be about 3.3 feet, the length between 5-foot contours 4,400 feet, the total fall 0.8 foot, and the mean rate of fall 1.05 feet per mile.

The bottom at both bars is composed of projecting rock reefs, bowlders, and gravel. The steamboat channel follows the center of the river, except near the mouth of Mink Creek, where for a short distance it approaches close to the right bank.

Historical.—The report of 1868 (Exhibit No. 3), states that there are no rock reefs in this vicinity, and suggests an improvement to secure a depth of 3 feet at low water by means of a wing dam 1,800 feet long, estimated to cost $4,800.

In 1875 Mr. Williamson made a detailed survey of this locality. From his maps and records it is seen that the available depth in the steamboat channel was 25 inches, and that the surface velocity in the channel for a stage of 4.5 feet above low water was 2.1 miles per hour. The plan of improvement shown contemplates the excavation of a channel near the right bank 150 feet wide and 3 feet deep at low water. No estimate of quantities or cost is given.

Proposed improvement.—The natural slope over the bar at low stages appears to be about 1 foot per mile, and the maps indicate the desirability of maintaining this condition. It is consequently proposed to provide a channel of standard dimensions at normal low water by dredging and to contract the waterway so as to maintain the desired depth under a surface slope of 1 foot per mile from the foot of Mink Creek to the head of Cross Bar. The maps indicate that a mean depth of 4 feet will result, for which, and the probable normal flow (9,200 cubic feet per second), the channel width obtained from Table No. 14 is 1,223 feet. It is anticipated that a normal level of elevation 572.7 will result at the head of Cross Bar.

The works to accomplish those results consist of short spurs from the right bank at Mink Creek Bar and from the left bank at Cross Bar, with a few sills between the two sets of spurs, as shown on plate No. 12, herewith. The cost of this improvement, utilizing part of the excavated materials for building spurs, is estimated as follows:

45,000 cubic yards gravel and loose rock excavation, at 25 cents	$11,250
30,000 cubic yards riprap in dams, at 75 cents	22,500
	33,750

A comparatively small amount of dredging will enable the realization of a depth of at least 4 feet over this reach at normal low water without the necessity for the construction of the spurs and dams shown. When, however, the full depth of 5 feet is necessary, contraction will be required in order to obviate the probability of a serious reduction in the surface elevation.

No. 27. North Sauty Bar (85.9 miles below Chattanooga).—This bar takes its name from North Sauty Creek, which empties into the river about midway of the obstruction. The available depth at extreme low water is 3.2 feet. At normal low water the channel will afford not less than 4 feet. The length between 5-foot contours is 4,400 feet, the fall 4.52 feet, and the mean rate of fall 0.65 foot per mile.

The bar is a compound of gravel and the depth of water on it is practically uniform.

Historical.—The depth being more than 3 feet at low water, the bar has never been recognized as a low-water obstruction.

Proposed improvement.—The profile shows that except for a short distance at the lower end of the bar the channel depth will be fully 5 feet for the normal level fixed by the proposed works at Cross Bar. Consequently it will only be necessary to do a small amount of dredging here in order to provide the desired width and depth. This is estimated to cost as follows:

8,000 cubic yards gravel excavation, at 25 cents	$2,000

The natural conditions found here correspond to a surface slope of 0.75 foot per mile at normal low water, and it is assumed that an elevation of at least 573.5 will be available at the head of the bar after the execution of the works at and below this bar.

No. 28. Larkins Towhead (84.1 miles below Chattanooga).—The obstruction here consists of a gravel bar to the right of and above the foot of Larkins Towhead. The available depth at extreme low water is 2 feet; the length over which the depth is 3 feet or less is 1,400 feet; the fall is 0.9 foot, the mean rate of fall 3.5 feet and the maximum rate 7.5 feet per mile. At normal low water the depth available will be about 2.7 feet, the length between 5-foot contours 5,200 feet, the total fall 1.5 feet, and the rate of fall 1.5 feet per mile. The towhead is close to the left bank, to which it is connected at low water. A second bar or towhead makes its appearance in the middle of the waterway at low stages. This latter bar appears to be the cause of the unusual fall found there.

Historical.—The examination of 1867 found a low-water depth of 2 feet for a length of 1,200 feet on this bar. The improvement then proposed consisted of a training wall 1,200 feet long, starting from the left bank about the head of the towhead, estimated to cost $3,199.50.

The survey of this locality in 1875 by Mr. Williamson was made with care and in considerable detail. The available depth at low water is given at 22 inches. The steamboat channel is shown to follow a circuitous course, in order to avoid reefs and shallow water. The surface velocity at a stage of 4.5 feet above low water was found to be 2.75 miles per hour. The plan of improvement proposed by Mr. Williamson, as shown by his map, consists in excavating a channel 150 feet wide and 3 feet deep at low water and in the construction of training works from each bank designed to confine the low-water flow to a width of 500 feet. The excavated channel follows the center line of the works. The length of the contracted waterway is about 1,200 feet and the dams are both above the head of the towhead. The location and extent of these dams are shown on plate 12 by dotted lines. The estimated quantities and cost of this work are not given.

Proposed improvement.—The natural condition of the reach above Larkins Towhead makes it essential to at least maintain the present normal level. With this and the improvement of the bar itself in view, the best plan appears to dredge through the bar and to contract the waterway so as to produce a uniform slope of 2 feet per mile for the full length of the bar, creating a normal elevation above the works of 575.5. The width of the contracted channel will vary with the attainable mean depth, being 855 feet when the depth is 4 feet and 1,065 feet when the depth is 3.5 feet. The plans and estimates are based on a mean between the two widths and depths given, or 960 and 3.75 feet. The necessary works, consisting of excavation and of spurs from the left bank, are shown on the accompanying drawings. The cost, utilizing as much of the excavated materials as possible, is estimated as follows:

25,000 cubic yards gravel excavation, at 25 cents	$6,250
15,000 cubic yards riprap dams, at 75 cents	11,250
	18,500

No. 29. Caldwells Bar (82 miles below Chattanooga).—This bar affords full 3 feet at extreme low water. At normal low water the available depth will be 4 feet, the length between 5-foot contours 3,800 feet, the fall 0.6 foot, and the mean rate of fall 0.5 foot per mile. The bar is composed of gravel and the depth is quite uniform over its entire length.

Proposed improvement.—For the normal surface elevation 575.5, which will probably result from the works at Larkins Towhead, it is found by calculation that the mean slope for 3 miles above the towhead will be about 0.5 foot per mile and that a channel of standard dimension can be excavated through Caldwells Bar without producing a material derangement of this slope. The cost of this excavation, which is indicated on the profile herewith (pl. No. 12), is estimated as follows:

15,000 cubic yards gravel excavation, at 25 cents	$3,750

No. 30. Chisenhalls Bar (78 miles below Chattanooga).—This bar is situated in a wide straight reach of the river at and below the Upper Section Ferry. It is composed principally of gravel, deposited between projecting reefs. The available depth at extreme low water is 2.7 feet. The length over which the depth is less than 3 feet is 2,600 feet, the fall is 0.8 foot, and the mean rate of fall, over the bar, 1.6 feet per mile. At normal low water the channel depth will not be less than 3.3 feet, the length between 5-foot contours 8,000 feet, the total fall 1.6 feet, and the mean rate of fall 1.05 feet per mile. A maximum rate of fall of 2.6 feet per mile was observed by the survey party.

Historical.—In his journal Mr. Williamson says that this bar is made up of narrow ledges, over which the depth at low water is never less than 2.9 feet, this being within one-tenth foot of the limit of the improvement then proposed. A detailed survey of the locality was not made.

Proposed improvement.—This locality is in the same category as a number of others already described, in that by a comparatively small amount of work it can be made to provide a channel depth of 4 feet at normal low water, and its final improvement to a depth of 5 feet can be delayed until most of the other obstructions have been removed.

In order to secure a depth of at least 5 feet and a suitable section at normal low water it will be necessary to resort to extensive dredging operations and to so contract the waterway as to equalize and at least maintain the present normal low-water slope and surface elevations. The map and profile (pl. No. 13) indicate that a slope of 1 foot per mile and a mean depth of 4 feet are attainable with comparative economy. The normal flow for this locality is 9,100 cubic feet per second. The mean channel width, corresponding to these quantities, is 1,220 feet. The water-surface elevation below the bar is assumed at 567.2 and the resulting elevation above at 568.7. It is proposed to outline a channel of the width stated and about 1.5 miles long by means of spurs from the right bank. The cost of these spurs and the necessary dredging are estimated as follows:

40,000 cubic yards gravel excavation, at 25 cents	$10,000
15,000 cubic yards riprap dams, at 75 cents	11,250
	21,250

No. 31. Jones Bar (75.2 miles below Chattanooga).—This obstruction takes its name from Jones Creek, which empties into the river from the left side, near the foot of the bar. The low-water depth is fully 3 feet, and the fall uniform. At normal low water the depth will be 4 feet, the length between 5-foot contours 4,000 feet, the

fall 0.6 foot, and the rate of fall 0.8 foot per mile. The bar is composed of gravel, held in place by occasional rock reefs. In 1875 Mr. Williamson found the available low-water depth to be 2.8 feet, although he was informed by pilots that but 2 feet existed.

Proposed improvement.—The survey seems to indicate clearly that this bar provides, or can easily be made to provide, full 4 feet at normal low water. This being the case, the final improvement to standard normal dimensions need not be undertaken until a depth of 5 feet is generally available. A study of the reach indicates that the dredging necessary to secure a 5-foot depth can be safely effected without resorting to special contraction works to maintain the surface levels. The resulting slope will be about 0.75 foot per mile, and should there be any question about the effect of the dredging on the upper level, by a judicious deposition of the dredged materials all possibility of injury can be avoided.

The cost of the necessary dredging is estimated as follows:

15,000 cubic yards gravel excavation, at 25 cents	$3,750

No. 32. Bellefonte Shoals; lower bar (72.8 miles below Chattanooga), upper bar (71.8 miles below Chattanooga).—These shoals are situated in the main channel of the river below Bellefonte Island. Numerous projecting rock reefs and detached bowlders obstruct the channel and make it necessary for steamboats to follow a circuitous course in order to take advantage of even the present scant depth at low stages. At extreme low water but 2 feet is available in the channel, and the total length over which the depth is less than 3 feet on both bars is 5,500 feet. The total fall is 1.45 feet and the mean rate of fall about 1.4 feet per mile. At normal low water the available depth will be about 2.8 feet, and the upper and lower bars form one, with a total length, between 5-foot contours, of 9,800 feet; the total fall is 2 feet and the mean rate of fall 1.05 feet per mile. A maximum rate of 2 feet per mile was observed by the survey party.

Historical.—The examination of 1867 makes no mention of this obstruction.

Mr. Williamson's journal gives the available low-water depth, reported by pilots, as 15 inches. His survey, which was made with care and in great detail, shows the least channel depth to be 2 feet. The mean surface velocity for a 4.25-foot stage was found to be 2.1 miles per hour. Mr. Williamson's map of the locality shows that he contemplated an improvement by excavating a channel through the bar 150 feet wide and 3 feet deep at low water.

Proposed improvement.—It is now proposed to provide a channel following approximately the line of deepest water near the center of the waterway. This channel will be 5 feet deep and not less than 100 feet wide at normal low water. In order to counteract the effect of this excavation, and also to raise the normal level at the head of the bar, the channel will be contracted so as to produce a mean depth of 4 feet and a uniform slope of 2 feet per mile over the bar. The width corresponding to these quantities and a normal flow of 9,000 cubic feet per second is 846 feet. The works to accomplish this consist of a dam at the head of Bellefonte Island to close the right chute, of a longitudinal dam for the foot of the island nearly one-half mile long, and of spurs from the right bank from Bellefonte Landing nearly down to Subletts Ferry. The cost of these works, which are illustrated on plate No. 13, making allowance for using the excavated materials in the dams, is estimated as follows:

30,000 cubic yards rock and gravel excavation, at 75 cents	$22,500
20,000 cubic yards riprap dams, at 75 cents	15,000
	37,500

No. 33. Coffee Bend Bar (65.4 miles below Chattanooga).—This bar is in Coffee Bend, about 1.5 miles below Crow Creek Island. It is composed of rock reefs, holding gravel deposits. The available depth at low water is 3.3 feet. At normal low water the depth will be about 4.1 feet; the length over which the depth is less than 5 feet, 2,500 feet; the fall 0.2 foot, and the rate of fall 0.4 foot per mile.

Proposed improvement.—The excavation necessary to provide the proposed normal low-water channel dimensions can be safely done without fear of affecting the normal levels or necessity for contraction works. The estimated cost of this improvement, for which no drawings have been made, is as follows:

10,000 cubic yards rock and gravel excavation, at 50 cents	$5,000

No. 34. Crow Creek Shoals; lower bar (63.3 miles below Chattanooga), upper bar (61.9 miles below Chattanooga).—These obstructions are in the right chute at Crow Creek Island, and extend downstream a short distance below the foot of the island. At extreme low water a depth of 2.5 feet is available at the foot and 1.8 feet at the

head of the island. The total length over which the depth is less than 3 feet is 2,400 feet. At normal low water the available depth at the head of the island will probably be about 3.3 feet, and for a length of 11,000 feet, including the whole chute and extending downstream fully one-half mile, the depth will be less than 5 feet. The total fall over these shoals is 2.2 feet, and the mean rate of fall 1.05 feet per mile. The bottom is generally gravel, with scattered reefs and bowlders.

Historical.—Mr. Williamson made a careful survey of these shoals in 1875, and his maps show a depth of 20 inches at extreme low water. The improvement proposed by him, and shown on his map, consisted of an excavated channel 150 feet wide and 3 feet deep at low water, and of a dam from the left shore closing the left chute and confining the low-water flow to the right chute. No estimate of cost or quantities is given. His observations gave a mean surface velocity of the current of 2.25 miles per hour, with a maximum of 3 miles per hour for a short distance.

Proposed improvement.—In view of the uniform shoalness and bottom slope in the right chute, it will be desirable to obtain the desired channel depth and dimensions by raising the water surface rather than by excavation, both on account of the cost and on account of the effect on the pool level above the island.

The general slope of the bottom is 2 feet per mile, and an examination of the maps shows that, if this slope is adopted, beginning about 2,300 feet below the foot of the island, with a normal surface elevation of 584.9, the chute is naturally adapted to the proposed condition and will afford a proper mean depth (5 feet) and width (594 feet) for the normal flow (9,000 cubic feet per second). The water-surface level throughout the chute will be raised from 1.5 to 3 feet, and at the head of the island the resulting elevation at normal low water will be 588.9.

The works proposed to carry out the plan above outlined consist of a dam connecting the head of the island with the left shore, designed to confine the normal flow to the right chute; of some excavation and possibly some contraction works in the chute itself, and of a longitudinal dam from the foot of the island, 2,100 feet long. These works are shown on plate No. 13 herewith, and are estimated to cost as follows:

15,000 cubic yards gravel excavation, at 25 cents	$3,750
15,000 cubic yards riprap dams, at 75 cents	11,250
	15,000

No. 35. Widows Bar; lower bar (56.2 miles below Chattanooga), upper bar (55.1 miles below Chattanooga).—At this locality the river has a width of nearly 1,500 feet, all of which for a distance of 1.5 miles is more or less obstructed by rock reefs, bowlders, and gravel bars. The steamboat channel follows the right bank. The available low-water depth at the lower bar is 2 feet; the length between 3-foot contours, 900 feet, and the fall, 0.1 foot. At the upper bar the low-water depth is 1.5 feet; the length between 3-foot contours, 3,600 feet; the fall, 1 foot, and the mean rate of fall, 1.43 feet per mile. At normal low water these bars become one; the available depth will probably be but little more than 2.3 feet; the length between 5-foot contours, 7,900 feet; the total fall, 1.3 feet, and the mean rate of fall, 0.87 foot per mile. The maximum observed rate of fall was 4.5 feet per mile.

Historical.—In his report of February, 1868 (Exhibit No. 3), Mr. Gaw says this obstruction is caused by projecting rock reefs, which extend across the river, on which the depth at low water ranges from 14 to 24 inches. The space between the reefs is filled with gravel and embedded bowlders. The improvement suggested consists of excavating a channel through the reefs and the construction of a wing dam from the left bank 800 feet long across the head of the bar and extended downstream parallel to the right bank for a distance of 1,000 feet. The cost of this work was estimated at $5,248.

The maps and journal of the survey made in 1875 by Mr. Williamson (Exhibit No. 5) show an available low-water depth of less than 1.5 feet. The plan of improvement outlined on his map consists of a dam from the left bank at the head of the bar, gradually contracting the low-water channel to a width of 550 feet, and then outlining it for about 500 feet parallel to the right bank. A channel along the right bank 150 feet wide and 3 feet deep was to be cleared of all obstructions by excavation. The estimated cost and quantities are not given.

In the fall of 1896 the reefs forming the head of the bar were drilled and blasted (see Exhibit No. 10b), but the work of removing the broken materials was not entirely completed until late in 1900, when the party under Captain Thompson cleared the channel of loose rock and reported (Exhibit No. 12) a depth of at least 1.9 feet in a channel 100 feet or more in width.

Proposed improvement.—The general slope of the bottom is shown by the profile to be about 3 feet per mile. Beginning the regulated channel 3,500 feet below

Widow Creek, with this slope at an assumed low-water level of elevation 588.5; the mean depth in a channel along the right bank will be about 4.5 feet, and the mean width for this depth, the slope adopted and a discharge of 8,900 cubic feet per second, will be 569 feet. The length of channel will be 8,000 feet, and the normal elevation at the head of the bar 593. If it were possible to determine in advance the proper normal width for the channel it is probable that the most satisfactory improvement would result from the use of a longitudinal dam, parallel to the right bank and connected with the left shore by frequent cross dams. In view, however, of the uncertainty of this determination and of the desirability of being able to modify the width of channel to correspond with the attainable mean depth, it is proposed to base the plans and estimates now submitted on the use of spurs from the left bank, supplemented by sills and excavation where necessary to bring about desired conditions of slope and depth. The location and extent of these works are shown on plate No. 14 herewith. The cost is estimated as follows:

20,000 cubic yards rock and gravel excavation, at 75 cents	$15,000
30,000 cubic yards riprap in dams, at 75 cents	22,500
	37,500

The probable maximum velocity in the channel at normal low water resulting from these works will be 4.79 feet per second, and during high stages it may increase to 7 or 8 feet per second. It is not thought that the banks will be eroded even under the later conditions, nor will upstream navigation be impeded, because the channel width is sufficient to allow boats to avoid the line of swiftest water.

No. 36. Hembrees Bar (52.5 miles below Chattanooga).—This bar obstructs the channel about three-fourths of a mile below Bridgeport Island. It is composed of rock reefs and gravel. The available depth at extreme low water is 1.8 feet, the length between 3-foot contours is 1,000 feet, the fall is 0.3 foot, and the mean rate of fall 1.5 feet per mile. At normal low water the available depth will be about 2.5 feet, the length between 5-foot contours 5,200 feet, the total fall 1 foot, and the mean rate of fall 1 foot per mile. The works already described at Widows Bar are expected to raise the normal level at this locality to at least elevation 593, making it possible to provide a normal channel of standard dimension by dredging through the bar. The cost of this dredging through is estimated as follows:

8,000 cubic yards gravel excavation, at 25 cents	$2,000

No. 37. Bridgeport Island Shoals; Island Bar (51.1 miles below Chattanooga), Bridge Bar (48.6 miles below Chattanooga), Upper Bar (47.4 miles below Chattanooga).—Bridgeport or Long Island has a length of nearly 5 miles, and divides the river bed into two unequal channels. The right has a width of about 1,200 feet, while the left is only about 400 feet wide. The left chute has always been recognized as the steamboat channel. The right, in addition to many natural obstructions, is closed to steamboat navigation by the bridge of the Nashville, Chattanooga and St. Louis Railway. The left chute is seriously obstructed at low water by the three bars above enumerated. At Island Bar the depth at extreme low water is not more than 1 foot. For a distance of 3,100 feet the depth is less than 3 feet, the fall is 1.65 feet, and the mean rate of fall 2.8 feet per mile. At normal low water the depth will probably not be more than 1.5 feet, the length between 5-foot contours 4,700 feet, the total fall 1.75 feet, and the mean rate of fall 2 feet per mile. The maximum observed fall is 18.5 feet per mile. This is probably the most serious obstruction on the Middle Tennessee.

The Bridge Bar is located at the Nashville, Chattanooga and St. Louis Railway bridge, and complicates the passage through the draw. The available low-water depth is 1.5 feet, the length between 3-foot contours 5,000 feet, and the total fall 1.3 feet. At normal low water the depth will be but little more than 2 feet, the length between 5-foot contours 8,700 feet, the fall 1.8 feet, and the mean rate of fall 1.1 feet per mile. The maximum rate of fall observed here by the survey party was 3.5 feet per mile.

The Upper Bar occupies the extreme upper end of the left chute. The available depth at extreme low water is 1.6 feet, the length between 3-foot contours 2,000 feet, the fall 0.3 foot, and the mean rate of fall 0.8 foot per mile. At normal low water this bar practically joins the Bridge Bar. The available depth will be less than 2.5 feet, the length between 5-foot contours 5,000 feet, the fall 0.7 foot, and the mean rate of fall 0.75 foot per mile.

The total fall between the head and the foot of the island is 4.5 feet, making the mean rate of fall 0.9 foot per mile. The bottom is composed of rock, bowlders, gravel, and clay.

Historical.—In his report (Exhibit No. 3) Mr. Gaw says that there are three reefs of flint rock in the steamboat channel, two above and one below the railroad bridge, on which the available depth at low water is less than 18 inches. He suggests an improvement by diverting about two-thirds of the low-water flow to the left chute. A wing dam 600 feet long is proposed at the head of the island in connection with an excavation through each of the three reefs mentioned. The estimated cost of this improvement, which was designed to give full 3 feet in the channel at low water, was $2,508.

In 1875 Mr. Williamson made a very complete survey of this locality. He states in his journal (Exhibit No. 5) that he judged the left chute to be most capable of improvement; that the bars consist of gravel and ledges of solid rock, and that the channel is very tortuous and hard to follow, and does not afford over 17 or 18 inches at extreme low water. From Mr. Williamson's maps it is seen that he proposed to connect the head of the island with the right bank, and thus increase the flow in the left chute, and in addition to excavate the channel to a width of 150 feet and depth of 3 feet wherever necessary. The estimated cost and quantities are not given.

In 1891 Capt. George W. Goethals, Corps of Engineers, caused a detailed survey to be made of the left chute by Mr. D. L. Sublett, assistant engineer. Based on Mr. Sublett's maps and report (Exhibit No. 9d), Captain Goethals submitted a project (Exhibit No. 9c) August 5, 1892, for an improvement consisting of excavation through the three bars and the construction of a dam at the head of the island across the right chute. The aim of this work was to give a low-water depth of 3 feet in a channel 150 feet wide. The estimated cost of the improvement was $34,100. Proposals were invited for executing this work, but as the bids were in excess of the estimate it was decided to use the U. S. dredge *Harwood* and to undertake the work by hired labor.

During the fall and winter of 1892 244 cubic yards of rock, 1,544 cubic yards of gravel, and 896 cubic yards of clay were removed by the dredge. In June, 1893, work was resumed, and during that season 21,512 cubic yards of gravel were removed from the Upper Bar, giving a channel 120 feet wide and 5 feet deep at the head of the island. One cut 40 feet wide was made through the bar at the bridge, forming a channel 5 feet deep for 1,800 feet (Exhibit No. 10). During the fall of 1894 work was continued above the bridge, and 3,003 cubic yards bowlders and 4,578 cubic yards clay and gravel were removed, at a cost of 35 cents per cubic yard.

The work proved too heavy for the dredge *Harwood*, and frequent delays for repairs were necessary. During September, 1894, work was commenced at Island Bar, below the bridge, and a channel 2 feet deep by 80 feet wide by 600 feet long, involving the removal of 889 cubic yards of solid rock and 31 cubic yards of gravel, was excavated. In July, 1895, the dredge *Harwood* broke down and was sent to the Muscle Shoals Canal for a thorough overhauling. On this account and because of high water nothing more was done at Bridgeport Island until May, 1896. During the following working season about 5,600 cubic yards of material was taken from the bar at the bridge, giving, according to the reports, a channel 100 wide, 2.5 feet deep, and 1,400 feet long.

During the low-water season of 1900 the party under Captain Thompson removed 88 cubic yards of loose rock from the channel at Island Bar and 15 cubic yards from the Bridge Bar, giving, according to Exhibit No. 12, a channel depth of 1.9 feet.

Effect of previous work.—It would be of great interest and value to know what the effect of the excavation above described has been, and it has been attempted to determine it by a comparison between the surveys and maps of 1875, 1891, and 1899. This comparison has not proved very satisfactory or convincing, because no definite connections were made between the various surveys, and because the survey of 1899 was too general in its scope to show small changes definitely. From a careful study of all the data it has been concluded that the following relation exists between the levels: Elevation 100, survey of 1875, equals elevation 590.3, survey of 1891, equals elevation 591.6, survey of 1899. Compared on this basis, the longitudinal profiles give the following indications: At Island Bar the removal of obstructions from the channel and the blasting through the main reefs forming the bar have resulted in a general reduction of the low-water surface elevations and in an aggravation of the fall. The obstruction appears to be worse than before any work was done.

At Bridge Bar the lowering effect of the excavation has been largely counteracted by the construction of the longitudinal dam above the bridge. This dam outlines a channel 200 feet wide, maintains practically the original low-water level at the head of the bar, and makes the fall much more uniform than before its construction, but because of the reduction in levels, due to the Island Bar works, the total low-water fall at the Bridge Bar is nearly 1 foot greater than in 1891.

The low-water surface at the head of the Upper Bar and the pool above appears to have been lowered about 1.5 feet by the excavation done in this vicinity.

Proposed improvement.—From a preliminary investigation it is found that in order to produce an available depth of 5 feet in the left chute at normal low water, without materially changing the natural dimensions of the channel, it will be necessary to divert the whole of the normal flow to it, and thus lay bare the upper portion of the bed of the right chute during a large part of each year. This does not appear expedient; consequently it is proposed to devise the improvement for a normal flow of 4,000 cubic feet per second and to contract the waterway at the various obstructions to correspond with this discharge and the other attainable conditions.

The normal level at the foot of Bridgeport Island, due to the works at Widows Bar, will not be less than elevation 593. The general slope of the bottom over Island Bar is 4 feet per mile. If we adopt this slope for the regulated channel, beginning about 600 feet above the foot of the island, the maps indicate the practicability of securing a mean depth of about 4.5 feet, for which, and a flow of 4,000 cubic feet per second, the channel width should be 220 feet. It is proposed to provide a channel of these dimensions by means of spurs from the island shore, and by excavation when necessary. The resulting normal surface elevation above the bar will be 569. The cost of this work, which is shown on plate 15, is estimated as follows:

10,000 cubic yards rock and gravel excavation, at $1	$10,000
12,000 cubic yards riprap dams, at 75 cents	9,000
Cost of works at Island Bar	19,000

The mean velocity in this channel for the normal flow will be 4.05 feet per second; the maximum velocity will probably be 5.53 feet per second As the river rises these velocities will increase, but it is not thought that the difficulty on this account will ever be insurmountable for boats in ordinary use. A slope of 3 feet per mile and a corresponding reduction in the strength of current can be obtained, if deemed advisable, at an additional cost of about $10,000.

The normal surface elevation at the foot of the Bridge Bar caused by the works just described will be about 596. The general slope of the bottom over this bar is 2 feet per mile, for which the mean depth will be about 4.5 feet. For these conditions, and a flow of 4,000 cubic feet per second, the channel width should be 312 feet. It is consequently proposed to outline a channel of the dimensions stated 4,500 feet in length along the left bank, beginning 1,200 feet below the Nashville, Chattanooga and St. Louis Railway bridge, by means of spurs from the island shore and of sills and excavations wherever necessary. The nature and extent of the works proposed to accomplish this are shown on the accompanying drawings (plate No. 15), and are estimated to cost as follows:

12,000 cubic yards rock excavation, at $1	$12,000
15,000 cubic yards riprap dams, at 75 cents	11,250
Cost of works at Bridge Bar	23,250

Table No. 14 shows that the probable mean and maximum velocities in the above-described channel at normal low water will be about 2.86 and 3.92 feet per second, a much more favorable condition than resulted at Island Bar.

It is anticipated that the contraction works at Bridge Bar will raise the normal surface level to elevation 597.7 at the head of the bar and to elevation 597.9 at the head of Bridgeport Island. This surface elevation will enable the improvement of the so-called upper bar by dredging alone. It will also be necessary to close the right chute by means of a dam so disposed as to raise the normal low-water surface to elevation 597.9 at the head of the island. This dam can be located at the head of the island or in the right chute. It is thought that the latter location will be best, as it will to some extent make this chute available to boats.

The cost of the work at the Upper Bar, including the dam in right chute, is estimated as follows:

15,000 cubic yards gravel excavation, at 25 cents	$3,750
12,000 cubic yards riprap dam, at $1	12,000
	15,750

The total estimated cost of the improvement of the left chute is therefore as follows:

Island Bar	$18,000
Bridge Bar	23,250
Upper Bar	15,750
	57,000

The profile of the right chute, which is also shown on plate No. 15, indicates a much more favorable and uniform condition than is found in the left chute, and it is thought, notwithstanding previous statements to the contrary, that a more satisfactory improvement would have resulted if this chute had been selected for the steamboat channel. A much greater width of waterway could have been realized, and the slope and velocity could have been materially improved. An improvement of this chute has been worked out and shown on plate No. 15. This consists of a contracted channel at the lower end 3,000 feet long, 827 feet wide, with a slope of 2 feet per mile, and mean depth of 4 feet under the normal flow; and of a second contracted channel at the bridge 4,500 feet long, 677 feet wide, with a slope of 3 feet per mile, and mean depth of 4 feet under the normal flow. In addition to these contractions, which are outlined by spurs from the right bank and a longitudinal dam from the foot of Bridgeport Island at the lower works, and by spurs from the right bank at the upper works, extensive dredging is necessary at the two bars between the bridge and the head of the island. The normal surface elevation at the head of the island resulting from these works will be elevation 597, or nearly 1 foot less than that due to the proposed works in the left chute. The cost of the works described and shown on plate No. 15 is estimated as follows:

50,000 cubic yards rock and gravel excavation, at 75 cents	$37,500
35,000 cubic yards riprap dams, at 75 cents	26,250
	63,750

If the previous adoption of the left chute for improvement and the establishment of the draw of the railroad bridge do not make the continuation of the improvement of the chute imperative, it appears that the improvement of the right chute is worthy of serious consideration and further investigation.

No. 38. Burns Island Bar (42.8 miles below Chattanooga).—This obstruction is in the right chute at Burns Island. The available depth at extreme low water is 2 feet; the length over which the depth is less than 3 feet 1,000 feet; the fall is slight and uniform. At normal low water the depth will be nearly 3 feet, the length between 5-foot contours 6,000 feet, the fall 0.73 foot, and the mean rate of fall 0.65 foot per mile. The bar is composed of gravel, with occasional rock reefs or bowlders. The steamboat track follows along the island shore.

Historical.—No mention is made of this locality in the early reports, and it does not appear that any work has ever been done in this immediate vicinity.

Proposed improvement.—The normal water-surface elevation at the head of Bridgeport Island resulting from the works proposed at that vicinity will be 597.9. Although Burns Island is 3 miles above, the intervening pool is so deep that no material increase in the surface elevation will occur, hence the same elevation is assumed. For this condition, in order to provide a channel depth of 5 feet it will be only necessary to remove the detached reefs and bowlders from the proposed channel and to dredge through the bar for a short distance. The extent and location of the work are indicated on the profile herewith (pl. No. 16), and is estimated to cost as follows:

12,000 cubic yards gravel excavation, at 25 cents	$3,000

No. 39. Hales Bar (33 miles below Chattanooga).—This is a gravel bar situated in a sudden enlargement of the river about 1 mile above Riggles Ferry. The steamboat channel follows close to the right bank, and a depth of 2.4 feet is available at extreme low water, the length between 3-foot contours is 1,700 feet, the fall 0.35 foot, and the rate of fall over the bar 1.06 feet per mile. At normal low water a depth of over 3 feet will be available. The length between 5-foot contours is 2,000 feet, the fall 0.46 foot, and the rate of fall 1.2 feet per mile.

Historical.—No mention is made of this obstruction in any of the early reports, probably because of the comparatively high stage existing when the examinations were made.

Proposed improvement.—It appears safe to assume that the normal elevation at the foot of this bar will not be less than 599, for which elevation the profile shows that it will be practicable to dredge a channel through the bar of standard form and dimensions. In order to provide against a silting up of this channel, it is proposed to reduce the width of waterway to about 1,100 feet by a longitudinal dam from the left bank, built of the dredged materials, as indicated on plate No. 16. The estimated cost of this work is as follows:

30,000 cubic yards gravel and rock excavation, at 25 cents	$7,500
10,000 cubic yards riprap dams, at 75 cents	7,500
	15,000

No. 40. *Kellys Bar (21.8 miles below Chattanooga).*—The maps indicate that this is not a serious obstruction. The depth at extreme low water is fully 3 feet, although the channel providing this depth is narrow. At normal low water the depth will be nearly 4 feet, the length between 5-foot contours 1,000 feet, the fall 0.15 foot, and the rate of fall 0.8 foot per mile. The bar is composed of gravel and is probably held by rock reefs.

Historical.—In his report (Exhibit No. 3), Mr. Gaw refers to the slight velocity of current met with here for a shoal place, and proposes to improve the bar by building a wing dam 1,500 feet long, extending upstream from the foot of the shoal, which he estimates to cost $3,000.

Proposed improvement.—It appears safe to assume a normal elevation of 601 and to provide by excavation a channel of standard dimension with reference to this elevation. The estimated cost of this work is as follows:

15,000 cubic yards gravel excavation, at 25 cents	$3,750

No. 41. Savannah Towhead (20.6 miles below Chattanooga).—This obstruction is due to an abnormal fall. The available low-water depth is 6.5 feet, the total fall is 1.3 feet, the mean rate of fall 6.5 feet per mile, and the maximum rate 23.3 feet per mile. At normal low water these conditions do not change very much. Savannah Towhead is a gravel and bowlder island which divides the waterway into two narrow channels about 350 and 400 feet wide. The right channel is the widest and is used by steamboats. The objectionable fall is near the head of the towhead, and the surveys fail to reveal the cause of the existing conditions. The bottom is rock, bowlders, and cemented gravel.

Historical.—The improvement of this locality does not appear to have ever been under consideration before.

Proposed improvement.—The simplest way to improve this locality would be to remove the obstruction at the head of the island which causes the sudden increase in slope; but because of the injurious effect of an improvement of this nature at the "Pan," 3 miles above, it is proposed to back or drown out the obstruction by means of sills in the channel below it. This will be accomplished by the submerged dams or sills shown on plate No. 16, which are designed to equalize the slope and reduce it to 4 feet per mile through the right chute and to afford the desired channel dimensions. The flow through this channel for an assumed mean depth of 5 feet and width of 400 feet is found by equation No. 5 to be 8,600 cubic feet per second, which is practically the normal flow at this locality; consequently it will be necessary to entirely close the left chute by a dam where crest is at the normal elevation above Savannah Towhead. The mean velocity corresponding to these conditions is 4.31 feet, with a maximum of 5.87 feet per second. These velocities will increase somewhat for higher stages, but will probably never become a serious menace to upstream navigation. The cost of the works indicated on plate No. 16 is estimated as follows, making an allowance for the removal of the obstructions at the head of the island:

3,000 cubic yards rock excavation, at $1	$3,000
9,000 cubic yards riprap in dams, at $1	9,000
	12,000

TOTAL ESTIMATED COST.

In addition to cost of the works above outlined and described and the usual percentage for supervision and contingencies, it will be necessary to make an allowance (estimated at $50,000) for the removal of snags and overhanging trees, and of detached obstructions from the reaches, not considered in detail. These considerations make the total cost of the improvement as follows:

Estimated cost of works described	$592,200
For removal of snags, overhanging trees, detached obstructions, and miscellaneous work	50,000
20 per cent added for supervision and contingencies	128,440
Total estimated cost	770,640

It has been attempted, at the risk of making this report too long and elementary, to outline not only a desirable plan of improvement, but also to give the available pertinent data and information concerning the physical character of this section; to consider and discuss the limits, methods, and principles usually employed, and, finally, to show the direct application of this information to the design of the works for the improvement of the individual obstructions under consideration. The plans suggested, while they may not always be the best for the purpose, represent the result of a careful and comprehensive study of the whole question from the standpoints stated, and afford the basis of a much more detailed estimate of cost than is usual in such cases.

Very respectfully, your obedient servant,

G. T. NELLES,
Assistant Engineer.

Maj. DAN C. KINGMAN,
Corps of Engineers, U. S. A.

EXHIBIT No. 2.

REPORT OF MR. J. E. HALL, SURVEYOR, ON SURVEY OF THE TENNESSEE RIVER BETWEEN SHELLMOUND AND BROWNS ISLAND.

CHATTANOOGA, TENN., *October 31, 1900.*

MAJOR: I have the honor to submit the following report with accompanying maps of the survey of the Lower Tennessee River between Shellmound, Tenn., and Browns Island, Alabama, made under the act of Congress approved March 3, 1899, appropriating $35,000 for improving the Tennessee River between Chattanooga, Tenn., and Riverton, Ala., and providing that as much of this sum as may be necessary may be used for the survey of the portion of this stretch of river which has not heretofore been mapped.

In pursuance of your orders the survey party which had been engaged in surveys of the Clinch and French Broad rivers, after completing the same, left Knoxville for Chattanooga August 12, 1899, with outfit in tow of the U. S. S. *Stephen H. Long.* Meeting the *Clinch* (a small light-draft steamer which had been engaged to tow the outfit to Chattanooga) 30 miles below Knoxville, the *Long* turned back, and the *Clinch* with the outfit in tow reached Chattanooga on August 14. The party was detained here for several days in order to make some necessary repairs on the outfit, and while in the vicinity was utilized in making a special survey of the following obstructions: Rolling Mill Shoals, Lookout Shoals, the "Skillet," and Savannah Towhead.

On Tuesday, August 22, the party and outfit arrived at the point where the survey of 1891, entitled the survey of the "Suck," terminated, and entered upon the proposed survey.

Field work.—The general scope of the field work was as follows: To ascertain the length, width, and general topography of the river; to determine the level of the water surface at the time of the survey and, as accurately as possible, the low-water plane, and to ascertain the fall at every shoal; to sound the river thoroughly, locating the obstructions to navigation and ascertaining the character of the bottom; to obtain data showing height of water at flood tides, and any information that might be of use in formulating plans for the improvement of the river.

Work in the field was begun on August 22, 1899, and the party was disbanded at Decatur, Ala., October 13, an office force of five men being retained. The total length of the survey was 136 miles.

Party.—The party organized in Chattanooga in May, 1899, for the survey of the Clinch River (with a few additional members) was used on this survey, the full force numbering 30 men. The means of transportation were a large quarter boat, two canvas-covered boats, one open flat 12 feet wide and 25 feet long (used on the Clinch River survey), and eight rowboats. The men were comfortably domiciled on the quarter boat, and the covered flats were particularly serviceable for kitchen and dining purposes.

Plan of work.—All measurements were taken by the stadia. The values of the wire intervals were determined and tested from time to time by each observer reading his instrument over a base line which had been carefully measured with a steel tape. Azimuths were determined and checked by observations on Polaris or 51 Cephei.

The party was subdivided as follows: Two shore-line parties, two level parties, and a sounding party.

The shore line.—The work of locating the shore line was done by two parties working on either bank of the river and connecting with each other at intervals of not exceeding 3 miles. The shore line formed the base of the survey, measuring the length and width of the river, and locating all sounding stations, all points where cross sections were taken for contours, all obstructions, and all topography in sight from the top of the bank. A system of check points used on the surveys of the Mississippi and Missouri rivers was adopted to enable the transit men to carry azimuth by long sights and check each other.

Leveling.—The leveling was done by two separate parties working on opposite sides of the river and checking frequently with each other, either by crossings or by water surface in pools. Whenever a serious discrepancy occurred, both lines were rerun and the error corrected. Benches were established at intervals of about a mile on either bank. High and low water marks were observed wherever obtainable. Water surface was observed as often as was necessary to determine the slope of the river. The plane of reference for the levels was transmitted from the Chattanooga gauge by the survey of 1891, assuming the zero of this gauge to be 630.64 feet above sea level. This elevation was originally arrived at by a comparison of railroad levels and barometric observations. On reaching Decatur with the survey this elevation was compared with a precise-level bench established in 1895 by Mr. O. W. Ferguson. The levels from Chattanooga were found to be 12.834 feet too high.

Soundings.—The soundings were made from the bow of a skiff, and up to a depth of 12 feet a steel-shod octagon pole, graduated to tenths of a foot, was used. Soundings of a greater depth were made with a lead line. The character of bottom was noted at each sounding. The soundings were located by polar coordinates, a stadia being held in the sounding boat, and the angle and distance thereto read by the observer from a sounding station on shore, using some located point as a back sight. Every second or third sounding of each range was thus located, the observer signaling the recorder in the sounding boat at every location. The ranges were made at right angles to the river, as near as could be estimated, and at a distance apart varying from 100 to 800 feet, depending on the depth of the water. Especial care was taken at the shoals, islands, and crossings. The soundings were taken at intervals of about 25 feet. The soundings were reduced to low water of 1881 (which is the stage represented by zero of the Chattanooga gauge) by means of the gauge readings at Chattanooga, Bridgeport, and Decatur, and a number of low-water references observed at different points along the river. A gauge was kept at the quarter boat, and the stage of water was also observed each day by the levelmen at the beginning and close of the day's work. The gauge readings at Chattanooga, Bridgeport, and Decatur are given below for August, September, and October, 1899, covering the entire time of the survey.

Gauge readings at Chattanooga, Tenn., and Bridgeport and Decatur, Ala., for August, September, and October, 1899.

Day of month.	August.			September.			October.		
	Chattanooga.	Bridgeport.	Decatur.	Chattanooga.	Bridgeport.	Decatur.	Chattanooga.	Bridgeport.	Decatur.
1	4.4	3.2	4.0	2.1	0.8	1.4	1.2	0.3	1.0
2	3.7	2.3	4.3	2.3	1.0	1.6	1.1	0.3	0.9
3	3.1	1.7	4.3	2.6	1.1	1.7	1.1	0.2	0.9
4	2.8	1.5	3.6	3.1	1.3	1.9	1.0	0.2	0.9
5	2.5	1.2	2.9	2.8	1.5	2.0	1.0	0.1	0.8
6	2.5	1.0	2.5	2.3	1.2	2.3	0.9	0.1	0.8
7	2.4	1.0	2.2	2.0	0.9	2.5	0.8	0.1	0.8
8	2.4	1.0	2.2	1.8	0.7	2.2	1.0	0.2	0.7
9	2.3	1.0	2.1	1.6	0.6	1.9	1.0	0.2	0.7
10	2.1	0.9	2.1	1.8	0.5	1.7	1.6	0.3	0.8
11	2.1	0.9	2.1	1.7	0.5	1.5	1.7	0.5	0.8
12	2.0	0.8	2.0	2.0	0.6	1.4	1.9	0.5	0.9
13	2.0	0.8	1.9	2.0	0.7	1.4	1.7	0.6	1.2
14	2.2	0.7	1.8	1.9	0.7	1.5	1.7	0.5	1.4
15	2.6	1.0	1.7	1.7	0.7	1.5	1.4	0.4	1.4
16	2.7	1.3	1.8	1.5	0.4	1.6	1.3	0.3	1.3
17	2.5	1.1	2.0	1.4	0.4	1.5	1.2	0.2	1.3
18	2.3	1.2	2.2	1.2	0.3	1.4	1.2	0.1	1.2
19	2.2	1.0	2.2	1.1	0.3	1.3	1.1	0.1	1.0
20	1.9	1.0	2.0	1.0	0.2	1.1	1.1	0.2	0.9
21	1.7	0.8	2.0	1.0	0.2	1.0	1.1	0.2	0.8
22	1.6	0.6	1.8	1.2	0.1	0.9	1.1	0.2	0.8
23	1.5	0.6	1.7	1.2	0.1	0.9	1.1	0.2	0.7
24	1.3	0.5	1.5	1.5	0.1	0.8	1.0	0.2	0.7
25	1.7	0.6	1.4	1.5	0.4	0.8	1.0	0.2	0.8
26	1.2	0.7	1.3	1.5	0.5	1.0	0.9	0.1	0.7
27	1.2	0.7	1.2	1.3	0.4	1.1	0.8	0.1	0.7
28	1.2	0.7	1.1	1.2	0.3	1.2	0.8	0.1	0.7
29	1.4	0.6	1.1	1.2	0.3	1.1	0.9	0.1	0.7
30	1.9	0.5	1.0	1.3	0.2	1.0	1.0	0.1	0.7
31	1.7	0.8	1.6	....	....	....	1.0	0.2	0.6

Zero of the Bridgeport and Decatur gauges, respectively, represents stages of 1.4 and 0.8 feet above low water.

Office work.—The office force, after completing the maps of the Clinch River, on May 1, 1900, began the work of office reductions for mapping this survey The azimuths and distances were corrected, soundings reduced to low water, and latitudes and departures computed for all courses. Frequent closures were made and the loops adjusted. The transit points were then platted to a scale of 500 feet to 1 inch on charts 2 by 3 feet inside the border. From these as a base the shore lines. soundings, contours, etc., were all located. The Ockerson rollers were used in putting on the topographical signs beyond the tops of the banks.

There are pertaining to this survey 38 charts. These show the relative dimensions of the river, the depth of water, character of bottom, height of bank, general topography, and all obstructions; also a longitudinal section giving the depth along the channel and the fall of water surface. A continuous map of the river is obtainable by joining these charts.

Before disbanding the office force it was decided to map the survey of 1891, in order to have a complete set of maps of uniform scale between Chattanooga and Browns Island. To cover the stretch of river between Chattanooga and Shellmound required 9 charts, similar to those described above, making a total of 47 charts between Chattanooga and Browns Island.

A continuous profile and an index map were also made. The profile shows the depth of water along the channel and the fall of water surface. The index map was drawn to a scale of 1 inch to 6,000 feet, and shows the relative position of each chart and the general shape of the river The divergence of the sides of the charts where the 1891 survey joins the 1899 survey is caused by the 1891 survey having been made from a magnetic meridian while the 1899 survey is referred to a true meridian, the declination being 3° 20′ west.

Cost of survey.—The cost of the field work, including the towing of the outfit from Knoxville and traveling expenses of the men, was $3,709.70. The office work, including all necessary material, cost $1,961.57, making the total cost of the survey and maps $5,671.27, or $41.71 per mile.

General description of the river.—The Tennessee River is formed by the junction of the French Broad and Holston rivers 4½ miles east of Knoxville, and flows in a southwesterly direction across the State of Tennessee to Chattanooga. Here its course changes to westward, being deflected by Lookout Mountain, and for the ensuing 20 miles the river may be regarded as cutting through the Cumberland Mountains. The course of the river through this section is tortuous in the extreme. Its current is irregular, its slope excessive, and the channel is contracted by the mountain slopes to less than one-half its normal width, forming numerous obstructions. After passing through the mountains the river changes its character, and from thence to Browns Island is generally wide and shallow, with a gentle slope. The obstructions are flat bars, mainly of cemented gravel or hardpan, in which large bowlders are embedded, but in some instances are of solid rock.

The towns along the river below Chattanooga are South Pittsburg, in Tennessee; Bridgeport, Guntersville, Triana, and Decatur, in Alabama, and a number of landings for towns several miles inland.

Obstructions.—The portion of the river known as the "Suck," or mountain section, is minutely described in detail in the report of the assistant engineer, Mr. G. T. Nelles, rendered January 17, 1900.

After passing the mountains the first noteworthy obstruction is near Bridgeport, Ala., and is caused by the river being divided by Bridgeport Island into two chutes for a distance of 5 miles. The right-bank chute has an average width of about 1,100 feet, and the left-bank chute, which is the steamboat channel, is about 500 feet in width. It is very shallow for the entire length of the island, and is obstructed by gravel deposits near the head and a number of limestone reefs crossing the railroad bridge and near the foot of the island, limiting the available depth to 15 inches at extreme low water. The project for improvement here was to excavate a channel giving a 3-foot depth at low water. Some work was done here, but owing to a lack of funds it was never completed. Other prominent obstructions are Widows Bar, Gunters Reef, Bird Iron Bar, and Limestone Bar. Widows Bar and Limestone Bar are of similar formation, and are caused by the river widening and flowing over limestone reefs.

Gunters Reef is caused by the river dividing at McKee and Henry islands, and is a submerged ledge of soft sand rock. The project for improvement at this point was to excavate a channel having a 3-foot depth at low water. The project was not completed owing to a lack of funds.

The following table gives the name and location of all the shoals between the mountain section and Browns Island; also the length of shoal, least depth at low water, and the character of bottom:

Name, location, etc., of all shoals in Tennessee River between the mountain section and Browns Island.

	Name of shoal.	Distance below Chattanooga.	Least depth of channel at low water.	Length of shoal channel (depth less than 3 feet).	Channel distance having depth less than 4 feet.	Character of bottom.
		Miles.	*Feet.*	*Feet.*	*Feet.*	
1	Oates Island	32	2.8	300	400	Gravel.
2	Hales Bar	33	2.0	600	800	Do.
3	Burns Island	44	2.0	500	2,100	Gravel; underlying rock ledges and bowlders.
4	State Line Bar	48	1.5	2,000	[1]4¼	Do.
5	Bridgeport Reef	50	1.8	2,500		Rock; ledges and reefs.
6	Island Bar	51	1.4	3,000		Do.
7	Hembrees Bar	53	2.0	800	2,400	Gravel.
8	Widows Bar	55	1.5	3,000	3,800	Rock; ledges and reefs.
9	Head Crow Creek Island	62	2.0	1,000	4,600	Gravel and bowlders.
10	Foot Crow Creek Island	64	2.0	500	2,000	Gravel.
11	Bellefonte Island Bar	72	1.4	400	1,500	Gravel and bowlders.
12	Bellefonte Crossing	74	1.4	800	1,600	Do.
13	McGuinns Bar	76	2.0	300	1,500	Gravel and loose rock.
14	Upper section	79	1.5	1,000	4,000	Gravel and bowlders.
15	Larkins Towhead	85	1.6	800	1,800	Do.
16	Davidsons Bar	89	1.4	400	1,200	Gravel.
17	Mink Creek Bar	90	1.5	900	3,000	Loose gravel.
18	Pine Island	97	2.5	800	4,000	Gravel.
19	Buck Island	101	2.8	600	1,200	Gravel and rock.
20	Henrys Island	103	2.8	600	1,000	Gravel and bowlders.
21	Gunters Reef	105	2.0	1,500	2,200	Soft rock.
22	Beards Reef	108	....	....	....	Has been improved.
23	Browns Creek Bar	109	1.8	600	1,200	Cemented gravel.
24	Allens Bar	118	2.0	600	2,200	Do.
25	Flint River Bar	125	....	....	....	Has been improved.
26	Chunns Bar	130	2.2	500	800	Gravel.
27	Burdine Bar	131	2.0	600	2,000	Loose rock and bowlders.
28	Lees Bar	140	2.6	200	500	Gravel.
29	Buzzard Bar	143	2.5	800	1,500	Do.
30	Limestone Bar	155	1.8	2,000	2,500	Limestone ledges.
31	S. Flint Bar	156	2.0	1,500	2,000	Gravel.
32	Byrds Island Bar	164	2.2	1,000	2,000	Do.

[1] Miles.

Respectfully submitted.

J. E. HALL,
Surveyor.

Maj. DAN C. KINGMAN,
Corps of Engineers.

NOTE.—In addition to the charts above mentioned, two charts on same scale and style (Nos. 39 and 40), covering the reach between the head of Browns Island and Lock A, Muscle Shoals Canal, have since been prepared from the map of survey made in 1891–92, by Mr. W. G. Williamson, assistant engineer, and are also transmitted herewith.

G. T. N.

FEBRUARY 5, 1901.

[EXHIBIT No. 3.]

EXTRACTS FROM REPORT OF MR. W. B. GAW, CHIEF ASSISTANT ENGINEER, PUBLISHED AS PART OF HOUSE EX. DOC. NO. 271, FORTIETH CONGRESS, SECOND SESSION, 1868.

CHATTANOOGA, TENN., *February 11, 1868.*

GENERAL: I have the honor to submit the following report of the survey of the Tennessee River from Chattanooga, Tenn., to its mouth at Paducah, Ky.

* * * * * * *

A covered barge for the accommodation of the party, and several small cutters for hydrographical purposes, with all the necessaries for the survey, having been procured at this point, the party commenced operations on Wednesday, the 18th day of September, 1867, at the levee at the foot of Market street in Chattanooga.

The river was at a very low stage at the time of commencing the survey, and continued steadily falling for some weeks, affording peculiar facilities for observation.

* * * * * * *

The party arrived at Paducah, Ky., December 20, and was disbanded on the 22d, with the exception of the engineers and pilot, who, by your instructions, were retained to assist in reducing the notes of the survey.

In this survey every obstruction known to river men was carefully examined, its peculiar feature noted, and plans and estimates made for its removal, but the greatest care was bestowed upon the survey of the Tumbling Shoals and the "Suck," 13 and 15 miles below Chattanooga, and upon that of the Elk River, Muscle, and Colbert shoals, near Decatur, Ala., of which maps and hydrographical charts have been carefully constructed, and the existing difficulties of navigation illustrated by accurate sketches.

* * * * * * *

Below is appended a list of obstructions to navigation from Chattanooga to Paducah, as surveyed by the party under my instructions, with plans suggested for their improvement and estimates of the cost of removing them, together with a consolidated tabular statement showing at one glance the entire estimated cost of removing every—even the least—obstruction to the navigation of the river at all seasons.

* * * * * * *

Kellys Shoals (*28 miles from Chattanooga*).—The obstruction at this place is a shoal place of about 1,000 feet in length, bottom gravel on the line of the channel and to the left of it, with a very slow current for a place so shallow. The proposed improvement is a wing dam on the right side, extending from near the foot of the shoal up the river and toward the right bank, the length of which will be 1,500 feet.

Estimate.

Riprap, 1,500 feet; wing dam, 6 feet wide on top, 4 feet deep, with slopes of 1½ to 1; 2,666 cubic yards, at $1.50	$3,999

Long Island (*63 miles from Chattanooga*).—This island is 6 miles long and about half a mile wide at its widest part. The Nashville and Chattanooga Railroad crosses the river about the center of the island. The steamboat channel is on the left side of the island, and in the channel are three reefs of flint rock, two above the railroad bridge and one below it, on which at low stage of the river there are but 18 inches of water. About two-thirds of the entire water of the river passes down on the right side of the island, but the chute is so wide that the water is very shallow, and this channel is only available for purposes of navigation at high water.

If one-half of the water was taken from the right chute and thrown into the left it is thought there will always be 3 feet of water on the reefs. To do this a wing dam will be required at the head of the island 600 feet in length, with a retaining wall at the point where the wing dam joins the island. It is also suggested that 1 foot in depth for a width of 100 feet be excavated from the three reefs in the left channel.

The estimate for the proposed improvement is as follows:

Riprap in wing dam, 700 cubic yards, at $1.50	$1,050
Riprap in retaining wall, 222 cubic yards, at $1.50	333
Flint rock excavation at the three reefs, 450 cubic yards, at $2.50	1,125
Total	2,508

Widows Bar (*74 miles below Chattanooga*).—The length of this bar is about 4,000 feet. The depth of water at the lowest stage of the river varies from 14 to 24 inches. Velocity of current, 2 miles per hour. The most shallow place is on a reef of rocks that extends across the river. Above the reef there is always plenty of water. On the reef at the lowest stage of the river there are only 14 inches of water. Just below it there are 20 inches, with a gravel bottom, which increases to 10 feet near the mouth of Widows Creek, 4,000 feet below the reef. Below the mouth of the creek there is always plenty of water. To the left of the point where the channel crosses the reef there is a large sand bar, over which the water always flows.

The improvement suggested is by building a wing dam across the head of the bar 800 feet long and a wall 1,000 feet long from the lower end of the wing dam parallel with the channel, thereby causing such an increase in the volume of water and velocity of the current as will cut out the gravel below the reef to a sufficient depth for all seasons of the year. The reef at the head of the shoal will also have to be excavated a depth of 30 inches and a width of 100 feet, the estimate for which improvement is as follows:

Estimate.

Riprap in wing dam, 2,920 cubic yards, at $1.50	$4,380
Riprap in wing dam, to be 1,800 feet in length, 280 cubic yards, at 60 cents	168
Solid rock excavation, 280 cubic yards, at $2.50	700
Total	5,248

Larkins Towhead (*112 miles below Chattanooga*).—At this place there are two sand bars, one at the upper end of the towhead and one on the right bank opposite, the channel running between them, with 2 feet of water at the lowest stage of the river, and a current of 2 miles an hour. The length of the shoal water is 1,200 feet. Above and below this shoal there is sufficient depth of water at all seasons of the year.

The improvement proposed at this place is by constructing a wing dam and parallel wall combined for a length of 1,200 feet, to be 6 feet wide on top, 4 feet deep, and the side slopes to be 1½ to 1, the estimate for which is as follows:

Estimate.

Riprap, 2,133 cubic yards, at $1.50	$3,199.50

Mink Creek Shoals (*117 miles below Chattanooga*).—The obstructions at this place resemble the obstruction at Widows Bar, with the exception of there being no reef at this place. The same plan and amount of wing dam is suggested as at Widows Bar, viz:

Estimate.

Riprap wing dam, 1,800 feet long, 6 feet wide on top, 4 feet deep, slopes 1½ to 1, 3,200 cubic yards, at $1.50	$4,800

Buck Island (*129 miles below Chattanooga*).—About a quarter of a mile above the head of the island the channel is very close to the left shore with a low-water depth of 20 inches. From this point to a point 1½ miles below there are three shoal places in the river, caused by large masses of rock scattered irregularly about in the channel. All these shoals have deep pools of water between them. The different shoals only average about 100 feet in length.

The improvement suggested is by a wing dam at the upper shoal and the removal of the rocks at the other three. The wing dam will be 500 feet long and have a cross-section area of 50 feet.

The estimate for the proprosed improvement is as follows:

Estimate.

Riprap, 1,111 cubic yards, at $1.50	$1,666.50
Excavation of large masses of rock in island chute, 160 cubic yards, at $2.50	400.00
Total	2,066.50

Town Island (*133 miles below Chattanooga*).—At the head of this island there are a lot of bowlders scattered about in the channel, which is close to the shore, with only 20 inches of water on them at the lowest stage of the river. If the rocks are removed there will be 3 feet of water in the channel, at the lowest stage of the river, down to Gunters Bar. The estimate for removing the rock is as follows:

Estimate.

Bowlders averaging 1½ cubic yards each, 23 cubic yards, at $2.50	$57.50

Gunters Bar (*135 miles below Chattanooga*) is a rock reef, extending across the river near the lower end of Town Island, on which, at the lowest stage of the river, there are but 10 inches of water.

To improve this place the reef will have to be excavated a depth of 33 inches and 100 feet in width.

The following is the estimate of the proposed improvement:

Estimate.

Rock excavation, 470 cubic yards, at $2.50	$1,175.00

Gunters Reef (*138 miles below Chattanooga*) extends across the river with 20 inches of water upon it at the lowest stage of the river and a current of about 2 miles an hour. This reef will have to be excavated for a depth of 2 feet and 100 feet in width to make the channel sufficiently large.

Estimate.

Rock excavation, 300 cubic yards, at $2.50	$750

Flint River Towhead (157 miles below Chattanooga).—Opposite this towhead, which is 1 mile in length, there are always 3½ feet of water. At the lower end of the towhead there is a large sand bar, the lower point of which is about in the center of the river.

The channel crosses from near the right bank to near the left bank, passing close to the lower point of the bar, a short distance below which, and in the center of the river, is another sand bar that at lower water is dry. Between the two bars the water is only 25 inches deep at the lowest stage of the river. This depth continues for a very short distance when the water again becomes deep enough at all stages of the river.

On the right side of the lower sand bar there is a channel in which, at the lowest stage of the river, there are 20 inches of water.

It is thought that if a wing dam is built connecting the two sand bars, thereby keeping all the water in the right-hand channel, the increased volume of water and velocity of current would cut out the channel to a sufficient depth, the bottom being composed of sand and fine gravel.

The length of wing dam to do this would be 300 feet, 6 feet wide on top, 4 feet deep, and have side slopes of 1½ to 1.

Estimate.

Riprap in wing dam, 533 cubic yards, at $1.50	$799.50

Whitesburg Shoals and Reefs (166 miles from Chattanooga).—The obstruction here commences at the head of Whitesburg Island, which is 3 miles in length, and in this distance there are three places at which the water is only 2 feet deep at the lowest stage of the river. The bottom of the river at these places is composed of sand and fine gravel. Each of the shoals mentioned is 125 feet in length. Between them are natural pools, in which there are from 6 to 7 feet of water at the lowest stage of the river.

Just below the foot of the island there is another shoal of the same character and dimensions as those already mentioned. These shoals are caused by the great width of the river, it being 1,200 feet wide in the island chute.

In a distance of 2 miles from the foot of the island downward there are three other shoals, on which there are only 2 feet of water at the lowest stage of the river. The first of these is situated three-fourths of a mile below the island, the second 1½ miles below, and the third 2 miles. The first is about 300 feet in length, and the obstruction is caused by bowlders scattered irregularly about in the channel.

The second is about 60 feet in length, and consists of solid rock reef of flinty limestone extending across the river.

The third is about 30 feet in length, and is also a flinty limestone reef extending across the river.

The improvement suggested at the three shoals in the island chute and the one just below the island is by a wing dam at each one of them to increase the depth of water and cut out the gravel bottom. This, it is thought, will give sufficient depth of water at all seasons of the year.

The aggregate length of these dams will be 1,600 feet and have an average area of cross section of 50 feet.

The improvement of the shoal, three-fourths of a mile below the island, will be excavation of the limestone reef 100 feet in width at the shoal, 2 miles below the island. The improvement will also be excavation of the limestone reef 100 feet in width.

The estimate of the proposed improvement is as follows:

Riprap in wing dams, 2,963 cubic yards, at $1.50	$4,444.50
Removal of 25 bowlders, averaging about 1½ yards each, at the shoals, three-fourths of a mile from the island, 37 cubic yards, at $2	74.00
Solid limestone excavation at the shoals, one-half mile from island, 333 cubic yards, at $2.50	832.50
Solid limestone excavation at the shoal, 2 miles from the island, 167 cubic yards, at $2.50	417.50
Total	5,768.50

Limestone Shoals (186 miles from Chattanooga).—These shoals are about 1 mile in length, with an average velocity of current of 2½ miles an hour. About 600 feet of the upper end of the shoals has a bottom composed of sand and fine gravel; then follows 2,600 feet of a rough rock bottom, having from 20 to 25 inches of water on the points of the rocks, with deep pools between, at the lowest stage of the river. Below this rocky bottom gravel and sand are again found for a length of about 2,000 feet, with a low-water depth of from 20 to 25 inches. The improvement suggested is the excavation of the rock bottom.

The estimate is as follows:

Limestone excavation, 3,000 cubic yards, at $2.50	$7,500

Elk River Shoals (*10 miles below Decatur*).—The obstructions at this point consist of a series of bars of a very hard limestone in strata of varying thickness. These break at right angles to the surface, over which the water rushes with a great but far from uniform velocity.

For the topographical features of these shoals reference is made to page 581 [Annual Report of the Chief of Engineers for 1868; see page 70, herewith] of this report, and also to the map of this part of the river, in sheets No. 2 and 3, and profile on sheet No. 4.

The plan recommended for the improvement of navigation at this point consists of a canal from Browns Ferry, extending along the river bottom on the north side of the river to the foot of Sluice Island, a distance of 10.3 miles; thence to the mouth of Elk River, a distance of 4,400 feet. The canal will be built in the bed of the river, between high embankments, protected inside and out by slope walls. A sufficient space is left between the canal and the shore for the outlet of Poplar Creek Slough. Estimates of the cost of constructing this canal are appended. For greater convenience it has been divided into sections.

The estimate of the work is based upon the plan of making the bottom of the canal low enough to enable the river above to feed it at low water. It is believed that by the construction of a dam across the Tennessee river 1 mile below Browns Ferry, at the head of Coxs Island, the water can be raised some 7 feet, thus saving some 640,000 yards of rock excavation, and probably 500,000 yards of earth excavation, thus reducing the cost one-half.

If this plan were adopted more masonry would be required at the upper end of the canal. On account of the limited time granted foı the completion of the survey, I was unable to obtain sufficient data for making an estimate of the work upon this basis, but I am decidedly of the opinion that the feasibility of this plan should be ascertained before the work of constructing the canal is commenced.

The dimensions of the canal for which the following estimates were made are 100 feet width at bottom, with a depth of water of 6 feet, and a slope in earth of 1½ feet horizontal to 1 vertical. The locks are to be 300 feet between the miter sills and 70 feet in width.

* * * * * * *

THE RIVER LEAVES THE MOUNTAINS.

The river may be considered as ending here (Kellys Ferry) its mountain career. The mountain ridges gradually recede from the river, giving place to fertile bottom lands until the river reaches Sequatchie Valley, where the bottom becomes a valley. Reefs, shoals, and eddies disappear from the river, and the only obstructions that present themselves are a few sand and gravel bars and some rock that yields to slight work.

At Bridgeport, Ala., the river enters the plains of Alabama. For 56 miles its course is nearly southwest, with a wide level region on its right and sand mountains on its left.

Throughout this distance the river is very uniform in its character, having a width of 1,500 feet, and, with the exception of Widows Bar and Guntersville Reef, with 12 and 14 inches of water, respectively, there is an average depth of 6 feet. The bed of the river consists of mountain limestone; bank from 25 to 30 feet above low water; easy slope, and covered with vegetation.

Sand Mountain, sometimes called Raccoon Mountain, lies 3 miles to the left of the river at Bridgeport and 6 miles to the left at Widows Bar. This ridge runs nearly south, and as the course of the river is southwest, the country spreads out into a broad valley some 20 miles below Widows Bar. On the right bank the bottom land is from 1½ to 2 miles wide; beyond this is the upland, 20 to 25 feet higher than the bottoms. These bottom lands and the few large islands in the river have the richest alluvial soil, subject to 4 feet overflow, which, however, is not considered objectionable, as the uplands furnish elevated sites for residences, and the overflow annually enriches the soil.

At Guntersville the river turns almost at right angles to its former course and flows northwest. The valley below this point is one of denudation, or scooped out in the horizontal strata of the carboniferous rocks.

Near Guntersville a low ridge of mountains is cut through by the river, exposing carboniferous limestone about 100 feet high. This is the last spur of the Cumberland Mountains which the Tennessee River meets in its course to the Ohio.

Viewing the river between Guntersville and Bridgeport as the arc of a circle, this ridge would be the chord, passing by Huntsville, intersecting the river near Guntersville, and onward south.

CHANGES ON THE FACE OF THE COUNTRY.

One notable feature of this portion is the absence of vegetation on the slopes of the river banks, indicating the sandy character of the soil. The country having been once in a high state of cultivation, but little timber is seen immediately on the river. The strong, red soil, so characteristic of North Alabama, the numerous water courses, and the undulating surface of the country, once justly entitled it to be called "the garden spot of the South."

From Bridgeport to Decatur the fall in the river does not exceed perhaps 20 feet in the distance of 100 miles, there being only two places—Guntersville and Widows Bar—where the river is extremely shallow at low water. With this slight fall the current is always moderate, in few places greater than 3 miles per hour at high water where the river is 30 feet deep.

From Decatur to Browns Ferry, the head of the lower series of obstructions, a distance of 12 miles, is found the best part of the river, lying between Muscle Shoals and the head of the river. The average depth is 9 feet at low water; least depth, 3½ feet; width, from 1,500 to 1,800 feet; current, 1½ miles per hour, and navigable in any part, even in low water. The river here resembles a lake. This character, and the proximity of a large slough and Swan Lake, would favor the opinion that the channel once washed against the low hills of the uplands, 3 miles east of Decatur. The force of the current is now directed against the Decatur bank, and as this is composed of limestone and a compact mass of gravel, cemented by oxide of iron, the present channel may be regarded as stable.

Below Decatur and to the left of the river the fertile valley of Courtland spreads out 15 or 20 miles from the river to the base of the terraced Sand Mountains of Alabama.

On the right of the river are the low, marshy bottoms, 3 miles wide to the uplands, diminishing at Browns Ferry to a few hundred feet.

As Browns Ferry may be regarded as the head of the lower group of shoals, a cursory view of the river and its valley between this point and Bridgeport will enable us to appreciate better the adaptation of the river as a great commercial highway, and the alluring advantages and bountiful natural wealth of the country.

From Browns Ferry a majestic river, broad, deep, and with gentle current at all times, is seen stretching for 100 miles above, through a valley abounding in the latent elements of prosperity; a river which in this distance is seldom seen to bear on its bosom a pellicle of ice, and a country whose climate is so genial that wheat is ripe for harvest by the time the green blades in the Northwestern States emerge from the snow. Yet, with this favorable combination of natural resources, the valley languishes for want of a cheap transportation to market, and this portion of the river, for purposes of constant and certain navigation, is as sealed as though the river had no outlet to the Mississippi Valley.

Such are the effects, not the magnitude, of the obstructions in the Chattanooga Mountains and at Muscle Shoals.

* * * * * * *

All of which is respectfully submitted.

William B. Gaw,
Civil Engineer, Chief Assistant Engineer.

Bvt. Maj. Gen. G. Weitzel,
Major of Engineers, U. S. A.

In submitting the foregoing report, General Weitzel says:

"With the plan suggested by him for the improvement of the obstacles of which he gives a list in detail I am fully agreed." * * *

"But I am firmly of the opinion that the estimates presented are entirely too low." * * *

"To improve the river from Chattanooga, Tenn., to Decatur, Ala., which, according to Colonel Gaw, would cost $58,901; according to my views, $90,000."

EXHIBIT No. 4.

EXTRACT FROM THE REPORT OF MAJ. WALTER M'FARLAND, CORPS OF ENGINEERS, TO THE CHIEF OF ENGINEERS, U. S. A., DATED MAY 25, 1872, ON THE PROPOSED LINE OF WATER COMMUNICATION BETWEEN THE MISSISSIPPI RIVER AND THE ATLANTIC OCEAN.

Alabama division, extending from Browns Ferry, at the head of the Muscle Shoals, up the Tennessee to the mouth of Short Creek, 2½ miles above Guntersville, Ala; distance, 75 miles by steamboat measurement. This portion of the river is broad, straight, and almost free from obstructions, with abundant water, except at Gunters Bar, Gunters Reef, Flint River Towhead, Whitesburg Shoals and Reefs, and Limestone Shoals, where, during the lowest stage of the river, the depth of water varies from 10 to 20 inches. Here, too, in the absence of an accurate survey, we are compelled to depend upon an approximate estimate, which I put at $75,000, to insure 3 feet depth at the lowest stage of the river, and 5 feet at the ordinary stage, with channel ways not less than 150 feet in width.

EXHIBIT No. 5.

EXTRACTS FROM JOURNAL OF MR. W. G. WILLIAMSON, ASSISTANT ENGINEER, CONCERNING THE SURVEY OF THE TENNESSEE RIVER BETWEEN BRIDGEPORT AND DECATUR, ALA.

June 8, 1875.—Received orders from Major McFarland to continue the survey of the shoals from Bridgeport, Ala., instead of returning to Loudon, as was intended. I immediately went to work to get the boats and parties equipped for the work, and was enabled to commence work by the 18th of June.

June 18, 1875.—Commenced sounding Long Island or Bridgeport Shoals this morning at 7 o'clock, the lines having been run on the last survey just finished. We took 44 soundings.

These shoals commence above the island and continue some distance below it. There are short intervals of deep water, but most of the distance, nearly 5 miles, the water is shoal. The left chute was the one examined, as it is the one now used by boats, and the draw of the bridge of the Nashville, Chattanooga and St. Louis R. R. Co. is over that chute, and it is, so far as I could judge from my examination, the chute most capable of improvement. The shoals consist of bars of gravel and ledges of solid rock. The channel is very tortuous and hard to follow, and does not afford over 17 or 18 inches at extreme low water; indeed it is doubtful whether boats can get the deepest water over these bars, as after passing one bar they are not always heading for the deep water over the next bar, and this makes it difficult to get the boat in position to strike the chute on the next bar. There are a great many snags.

June 19, 1875.—I left on steamer *Emma*, Captain Samuels and Captain Spiller, and the pilots pointed out each shoal as we went down, and I annex a list of them as given me, with the distances, which I think are incorrect. The depth of water and the character of the shoals as they gave them to me I consider reliable.

List of shoals from Bridgeport to Decatur, Ala.

No.	Name.	Distance between shoals.	Total distance from Bridgeport.	Depth of water at extreme low water.
				Inches.
1	Long Island	0	0	15
2	Widows Bar	7	7	15
3	Crow Creek	12	19	20
4	Coffee Bend	6	25	....
5	Bellefonte	5	30	15
6	Jones Creek	8	38	24
7	McGuinns Ferry	3	41	120
8	Larkins Towhead	10	51	22
9	Sycamore Shoals	4	55	20
10	Swaffords	2	57	20
11	Romans Landing	2	59	18
12	Pine Island Chute	1½	60½	22
13	Buck Island	6	66½	18
14	Henrys Shoals	3	69½	48 or 60

List of shoals from Bridgeport to Decatur, Ala.—Continued.

No.	Name.	Distance between shoals.	Total distance from Bridgeport.	Depth of water at extreme low water.
				Inches.
15	Henrys Island	1½	71	20
16	Gunters Reef	1	72	15
17	Gunters No. 2, or Beards	2	74	18
18	Beards Creek	1	75	....
19	Paint Rock	11	86	24
20	Flint River	9	95	16
21	Chunns Shoals	5	100	20
22	Whitesburg	1	101	20
23	Big Sycamore	¾	101¾	20
24	Burdine	1	102¾	20
25	Lewis Bend	9	111¾	20
26	Triana	4	115¾	22
27	Gillsport	7	122¾	20
28	Bracks Bar	1	123¾	....
29	Limestone Bar	8	131¾	20
	Decatur (no bar)	6	137¾	....

June 24, 1875.—Finished the survey and sounding at Widows Bar; took 28 cross sections. Bench marks were established on the right bank. Examined a bar described as Cedar Bluff; found 3 feet water at low water. I learned from a pilot on the *Emma* that the real bar was called Coxs Mound, and was just opposite a mound of that name; that there was always 2 feet of water on the bar, and that it was not over 600 feet wide. Therefore, 1 foot dredging, 200 feet by 600 feet, will give a waterway.

June 25, 1875.—Moved on to-day to the mouth of Crow Creek. Engaged all day examining shoals, moving, and determining where to commence and end the survey of Crow Creek Island Shoals; commenced the survey and ran 4,000 feet.

July 1, 1875.—Moved camp to-day, examining Coffee Bend as we passed; found plenty of water. Arrived at Bellefonte Shoals and examined them, so as to find out where to commence work.

July 3, 1875.—Ran 11,000 feet, making the survey of Bellefonte Shoals; took 27 cross sections.

July 5, 1875.—Finished both the lines and the survey of Bellefonte Shoals to-day; took 26 cross sections.

July 6, 1875.—Moved camp and examined the following bars as we passed on down the river:

Jones Creek, said by pilots to afford only 2 feet of water at low water; we could not find less than 2.8 feet at low water. Mr. Hitch, ferryman at McGuinns Ferry, gave us low-water mark, and we found it 0.15 above what our gauge called for, the water being by his mark 4 above low water, and by our staff 4.15 above low water. There are no shoals at McGuinns Ferry.

Chisenhalls Bar below shows 3 feet water at low water. The water is shoal for 6 or 8 miles below Bellefonte. At Jones Creek there are two bars making out into the river, one from the right bank and one from the left. But after a careful examination I could not find less than 2.8 feet of water at low water, and do not think a survey necessary for an approximate estimate.

Chisenhalls Bar seems to consist of very narrow ledges, but we could not find less than 3 feet of water in the channel at low water, and, therefore, we would not stop for a survey. We made a very careful examination of this bar, too, with the above result.

On reaching Larkins Towhead we found a gravel bar extending entirely across the river with a channel near the right bank, and after passing the bar, running along the right bank a short distance, and then making to the left. Below the shoals is a reef of standing rock, which should be removed. Near the left bank lies the towhead, and is, as it were, the nucleus of the bar. The narrow chute between this towhead and the left bank is very shallow and swift.

July 9, 1875.—Took 6 cross sections and triangulated the position of a rock reef below the shoals by 10 o'clock. We then moved camp to the mouth of Mink Creek, on the right bank below Swaffords Shoals. We ought to have stopped a mile and a half above, about half a mile below Sycamore Shoals, but owing to the height of the water and our not having a pilot, we could not find the shoals. The whole day was consumed sounding and trying to find the head and foot of Sycamore Shoals.

July 10, 1875.—We commenced the survey of Sycamore Shoals to-day; ran about

3,000 feet on each side of the river; took 14 cross sections. These shoals seem to consist of a series of rock and sand bars, with water enough in the channel, but the channel is so crooked that it is difficult to follow, and is probably impassable at low water. Water stood to-day 4.8, 5, and 5.05 above low water at 6 a. m., 12 m., and 6 p. m.

July 12, 1875.—Took 14 cross sections by dinner time, finishing Sycamore Shoals. The water was 4.7 above low water, and I did not commence sounding Swaffords Shoals. Water gauge read as follows: 4.75, 4.7, 4.75, rising slowly. It commenced raining after dinner, and rained all the afternoon and all night.

July 13, 1875.—Ran about 3,500 feet on the left bank at Swaffords Shoals. The water was too high to sound. It rained until late in the day. This morning and after dinner commenced again. At present writing, 8.30 p. m., water is 5.6 above low water, and rising rapidly. Water gauge read as follows: 5, 5.20, 5.60.

EXHIBIT No. 6.

EXTRACTS FROM THE ANNUAL REPORTS OF THE CHIEF OF ENGINEERS, CONCERNING THE IMPROVEMENT OF THE TENNESSEE RIVER, BETWEEN CHATTANOOGA AND MUSCLE SHOALS.

[Annual report 1877, pp. 580, 590, and 591.]

Elk River Shoals.—These shoals are at the upper end of the chain of obstructions known as Muscle Shoals, and their improvement has been contemplated and estimated for in all schemes for the improvement of the Tennessee River.

The usual plan recommended has been to extend the Muscle Shoals Canal along the north side of the river and around these shoals to a point near the upper end of Browns Island. (See map herewith.) The estimate for this is $1,115,000. It will be noticed that this line crosses the mouth of Elk River, a stream but little known, but which drains more than 2,000 square miles of country, or about the area of the whole State of Delaware. To cross this stream, except by an aqueduct, would be an extremely dangerous experiment, and would require a guard lock below the river high enough to reach above the highest floods in either Elk River or in the Tennessee.

With a view to avoiding this difficulty and of taking advantage of some 5 miles of deep water in the Tennessee above the mouth of the old canal, a resurvey of the south shore of the river from Browns Island to Lambs Ferry was authorized by the Chief of Engineers, and was completed in January last by Mr. Paul Le Hardy, whose report is appended. From this it appears perfectly feasible to take the south side of the river, and that the cost will be greatly reduced thereby. His estimate, which appears liberal and includes 25 per cent for contingencies, is $736,249 or $378,750 less than the lowest estimate for the canal on the north side of the river. [See also Exhibit No. 6a.]

[Annual report 1878, p. 756.]

Elk River Shoals.—Further examination confirms the opinion expressed in the last report that this obstruction can be overcome at a much less cost than originally estimated; and as soon as the new appropriation was available an outfit of boats, tools, and supplies was procured for a large force of workmen, authority having been obtained to do the work by hired labor.

The work is now making good progress. Boats and cabins for the men are being built, and a temporary dam 2,000 feet long has been built from the south shore to Browns Island, which will enable the excavation of reefs in the channel at the head of the shoals to be carried on to good advantage, as has been done at Little Muscle Shoals under similar conditions. Mr. Samuel Whinery, assistant engineer, is in local charge of this work and is pushing it with energy.

[Annual report 1879, p. 1249.]

At Elk River Shoals the work of excavating the rock reef at the head of the shoals was continued until the end of November, when the water rose so high as to put a stop to this work for the season. The force was then put to work in quarrying and boating stone and building the retaining dam which forms the channel around Milton Bluff. Some 30,000 cubic yards of rock were thus quarried and built into the dam during the season, forming about 2,347 linear feet of completed dam and 2,385 feet more which was raised above the water. As soon as the water became low enough to resume work in the channel, which occurred in June last, the force was again removed to the head of the shoals, and after putting up cabins to accommodate 300 men, and making some repairs to the temporary dam, which had stood almost uninjured through the high-water season, the rock excavation was resumed and was making considerable headway at the close of the fiscal year.

During the year 1,500 cubic yards of rock were excavated from the channel. It is hoped that during the present low-water season all the channel excavation at this point will be completed, or at least cut through the reef to a width of 80 feet, which will make the work practically independent of the stage of water in the river, as the dams can be built at almost any time during the year. The short piece of canal required just below Milton Bluff can also be built without waiting for low water, and there will be nothing but want of funds to interfere with the speedy completion of the Elk River Shoals improvement, so that it will be available as soon as the Big Muscle Shoals Canal is completed. Mr. Samuel Whinery has continued during the year as assistant engineer in charge of this work, and has had an average of 180 men under his supervision.

[Annual report 1880, pp. 1671 and 1672.]

Elk River division.—The channel excavation opposite Browns Island was continued until the 21st of October, when the small remaining force was removed to the quarries at and below Milton Bluff, where it was employed in quarrying stone and completing and extending the retaining dam around Milton Bluff, and eastward toward the lower end of Browns Island.

Eleven thousand two hundred and forty-six cubic yards of rock were blasted and removed from channel, 4,516 cubic yards of rock quarried, 7,766 cubic yards of rock put in dams, 2,342 cubic yards of earth were stripped from the quarries and placed in the dams at such points as an earthen filling was required.

The dams were substantially built, and have safely withstood the heavy floods of the last winter.

A suitable quarry for dimension stones for the locks was hunted up and opened so far as to demonstrate that the stone was of an excellent quality, both as to durability and ease of quarrying and cutting.

It is hoped that the present season's work will complete the channel excavation and so far extend the permanent dam that the temporary dam can be removed, and the first 5 miles of this shoal will become navigable, so that all our supplies may be boated down to the first lock below Milton Bluff.

[Annual report 1881, pp. 1842 and 1843.]

Elk River Shoals division.— * * * It was hoped that last season's work would finish the necessary channel excavation, but funds were not available until July 9, 1880, and, owing to the difficulty in getting a sufficient force together, it was found impossible to get through before the work was stopped by high water.

There is every indication that the present season will see this channel work completed, and the retaining dam so far extended that supplies can be shipped by water to the camp at Milton Bluff.

[Annual report, 1882, pp. 1839 and 1840.]

Elk River division.— * * * The channel excavation opposite Browns Island, where the bed of the river required more or less blasting out for a distance of nearly 2 miles, requiring the removal of 39,750 cubic yards of rock, was accomplished by inclosing successive portions of the channel in cofferdams and then pumping the water out so as to admit of rapid and satisfactory work. The last of these cofferdams was cleared out in September, just in time to escape the high water, and nothing more will be required to render this part of the river navigable as far down as Milton Bluff when the retaining dam below Browns Island is completed. This dam is more than four-fifths done and can easily be completed in one season.

EXHIBIT No. 6a.

EXTRACT FROM REPORT OF MR. PAUL LE HARDY, ASSISTANT ENGINEER, DATED JANUARY 29, 1877, BEING PART OF APPENDIX R, PAGES 589 AND 590, PART I, ANNUAL REPORT OF THE CHIEF OF ENGINEERS FOR 1877.

CHATTANOOGA, TENN., *January 29, 1877.*

CAPTAIN: I beg to submit herewith my report on the examination of the Tennessee River from Guntersville, Ala., to Browns Ferry, and on the resurvey of the Elk River Shoals.

In accordance with instructions received from you, dated October 23, 1876, I proceeded to Guntersville to take charge of the survey boats left there by Mr. W. G. Williamson, assistant engineer.

Rainy weather having set in just before my arrival at Guntersville, I was anxious to reach the Elk River Shoals before the river became too high and muddy to permit of a satisfactory examination there. I therefore made hurried examinations of the various obstructions between Guntersville and Browns Ferry without stopping the large boats; for, owing to the very low stage of the river, there was very little current, and the small number of men we could accommodate on the boats made our progress slow enough.

At Guntersville the river is about 30 feet deep. This depth gradually decreases as we approach Beards Reef, 2 miles below Guntersville. This consists of a ledge of limestone running straight across the river from the south bank to within 250 feet of the north bank. At low water there is a depth of only 1.8 feet in this channel, while the reef is almost bare.

About 400 feet below this "chute" is a broad gravel bar extending from the north bank halfway across the river, compelling boats to turn immediately below the reef and run to the south side of the river.

Three-quarters of a mile below this reef, Beards Bluff, a high limestone ridge, ends abruptly at the water's edge and causes the river to take a northerly course for a couple of miles. The water is over 10 feet deep opposite this bluff, and remains deep down to the mouth of Flint River, 18 miles below Guntersville. There are two snags in the channel opposite, or a little below the mouth of Flint River. The water is from 4 to 10 feet deep in the channel, which at this point is on the north side, but turns to the south side from just below the mouth of the Flint.

From this point there is deep water to Hobbs Island, which begins about 23 miles below Guntersville. The main channel is on the south side, and the least depth found is about 4 feet until near the foot of this island, which is about 3 miles long, where a reef extends across the channel, and there is not over 2 feet of water on it at the lowest stage. As the current is not very strong, gravel and some drift form a bar extending a few hundred feet below the reef.

One mile below this reef is Whitesburg, a landing some 9 miles south of Huntsville and about 27 miles below Guntersville.

Three-quarters of a mile below Whitesburg is a reef or broad, shallow limestone bar, on which there is at low water only about 2 feet depth, the "chute" being near the middle of the river; fall very light.

From here the river becomes deep again for a long distance.

Limestone Shoals, the next obstruction, is about 55 miles below Guntersville. The river here averages about 2,000 feet in width, bottom very even, of solid limestone.

A reef extends across the river about three-fourths of a mile below the mouth of Limestone Creek, over which there is 2½ feet at low water, with shallow water for about 100 yards above and below the reef.

The steamboat channel is from 200 to 300 feet from the north bank, and a dangerous rock stands on the reef just in the channel.

From Limestone Shoals to Decatur, about 6 miles, there is good water without obstructions.

At Decatur the "draw" in the Memphis and Charleston Railroad bridge gives a channel of about 60 feet only, and is too close to the shore to allow an easy passage to steamboats.

From Decatur to Browns Ferry, a distance of 12 miles, there are no obstructions.

To improve the river at the various points already mentioned I would propose the following plans, viz:

At Beards Reef a wing dam thrown across the stream just below the reef from the south bank to the outer edge of the boat chute probably will give depth enough in the channel; another dam below to prevent the water thus gained from being lost over the gravel bar.

1,500 linear feet of riprap dams, at $10 per linear foot	$15,000

At mouth of the Flint the removal of two snags will leave the channel clear of obstructions, with a depth of from 4 to 10 feet at low water.

Removing two snags, at $25 each	$50

At Hobbs Island a wing dam about 600 feet long will, it is believed, give the required 4-foot depth at low water.

Opposite or a little below the head of Hobbs Island stone could be had from Coffee Bluff.

600 linear feet of riprap dams, at $10 per linear foot	$6,000

At Whitesburg Shoal, as this place is shallow for some distance, excavating a channel would be too expensive, and the fall being very light perhaps the best way to overcome the shallow water is to build two wing dams from the opposite shores, leaving a channel where there is most water now.

1,500 linear feet of riprap dams, at $10 per linear foot	$15,000

At Limestone Shoals a dam along the reef from the south bank to the boat channel near the north bank and a retaining dam of about 100 yards would make the channel available to boats drawing 3 feet of water.

2,000 linear feet of riprap dams, at $10 per linear foot	$20,000

Elk River Shoals.—The survey of this portion of the Tennessee River was begun on the south bank a little above the head of Browns Island. Search was made for some station of the survey of 1871 as a point to start from, but none could be found; the original line having been run in fields, the stakes were all plowed up. Bench marks had been mutilated and the elevations completely effaced by time. A line of levels was started with an assumed elevation of 500 feet above tide.

Frequent triangulation was made to ascertain the width of the channel and especially to locate lines of soundings.

Down as far as station 59 + 67 the depth of water ranged from 4 to 10 feet. Frequently this depth could be found right close to the banks.

Below station 59 + 67 commences a series of reefs extending across the channel and down as far as station 94; least depth of water in boat chute is 1.8 feet at lowest stage, but the chute is so crooked as to be entirely unavailable at low water for other than light flatboats.

It is therefore deemed necessary to extend a riprap dam from the island toward the south bank and a retaining dam down to the foot of this shoal, thus making a channel along the south bank of the river. Some rock excavation will be necessary to remove the crests of the reefs.

The fall on this shoal is 0.89 foot in 3,400 feet, and will be no impediment to navigation.

From station 94 to station 120 there is from 3 to 4 feet of water in the channel.

Opposite station 120 begins another series of reefs, extending down as far as station 145, with very nearly 4 feet in the channel between the reefs. As the best water is in the middle of the river, I propose to raise the water by building at the foot of the shoal two wing dams from both banks toward the chute, leaving an opening about 400 feet wide.

Some excavation will also be necessary to clear the channel of some projecting rocks and a portion of the upper reef.

The fall on this shoal is 0.64 foot in 2,500 feet.

From station 145 to the foot of Browns Island the depth of water is from 4 to over 10 feet. But the river is shallow halfway from the foot of the island to the south shore, and remains shallow down to Milton Bluff, a mile and a half below.

A series of reefs, with shallow water between them, begins a little below the foot of Browns Island and continues down to Milton Bluff. The river here becomes very wide, and the fall is greater than on the previous shoals.

It will be necessary to confine the water of the south side of Browns Island into a narrower channel. A dam must be built from the foot of the island almost directly downstream to a point opposite Wild Goose Towhead, about 800 feet to the right of it, and from here a stronger dam to the towhead. This is to prevent driftwood from accumulating in the channel as it narrows below. From the towhead a retaining dam gradually approaching the south shore down to station 314, where the channel would be about 300 feet wide.

The fall from the foot of Browns Island to eddy water, opposite the foot of Milton Bluff, is 3.12 feet in 7,000 feet.

* * * * * * *

Very respectfully, your obedient servant,

PAUL LE HARDY,
Assistant Engineer.

Capt. W. R. KING,
Corps of Engineers, U. S. A.

EXHIBIT No. 7.

REPORT OF LIEUT. H. E. WATERMAN, CORPS OF ENGINEERS, ON EXAMINATION OF UPPER ENTRANCE TO THE ELK RIVER SHOALS CANAL, TENNESSEE RIVER.

ENGINEER OFFICE, UNITED STATES ARMY,
Nashville, Tenn., January 15, 1888.

SIR: I have the honor to make the following report of an examination, made under my direction, of the upper entrance to Elk River Shoals Canal, Tennessee River. This examination was made entirely with a view of straightening the present steamboat chute, and of conducting it entirely along the left bank of the Tennessee.

The map and profiles inclosed indicate the results of this examination. The soundings were in the main located in exact position with the transit.

As the dams exist at present, I think that extreme low water would reduce these soundings by a foot, but as it seemed to me that, with the dams entirely completed and tight, this loss would be more than counterbalanced, I have assumed our soundings as taken at low water.

The outside boundary of the proposed new channel is indicated by the red lines on the map, A–B, C–D, the inside boundary being approximately the present shore line. This location, with a few very slight turns, will give steamboats a straight course into the canal.

The profile along the E–M (green) line is given on the map. For a steamboat channel 100 feet wide and 6 feet deep at low water this profile indicates that the excavation of 66,260 cubic yards of solid rock will be necessary.

Profiles are also shown giving the condition of the present steamboat chute. From these it appears that to obtain 6 feet at low water it will require the excavation of 7,903 cubic yards of solid rock in the upper chute and 11,491 cubic yards in the lower, or a total of 19,394 cubic yards.

In short, to construct the new channel will take about three times as much work as to repair the old, but in spite of this I think there can be no question of the advisability of it.

The left bank of the river will furnish a very good guide for pilots, and the course is so nearly straight that signal lights on the pier at Miltons Bluff could be established which would furnish the necessary direction almost up to the head of the channel excavation.

So much of this kind of rock excavation has been done at this site that probably a close estimate of its cost per cubic yard can be made from facts on file at the Chattanooga office, so I have omitted estimates of cost.

Very respectfully, your obedient servant,

H. E. WATERMAN,
First Lieutenant of Engineers.

Lieut. Col. J. W. BARLOW,
Corps of Engineers, U. S. A.

EXHIBIT No. 8.

REPORT OF MR. W. G. WILLIAMSON, ASSISTANT ENGINEER, ON SURVEY OF TENNESSEE RIVER FROM BROWNS FERRY TO LOCK A.

UNITED STATES ENGINEER OFFICE,
Wheeler, Ala., April 6, 1893.

CAPTAIN: I have the honor to submit the following report on the survey from Browns Ferry to Lock A, which was made for the purpose of estimating the excavation required at Browns Island Chute, in order to change the location of the channel from its present position to that of a channel down the left bank of the river.

The survey was commenced in 1891, and interrupted by high water. It was recommenced September 1, 1892, Mr. S. B. Williamson being in charge of the party. The first 172 stations, a little over 3¼ miles, were found to have been plowed up by persons cultivating the land, and were, therefore, rerun. The sounding was then continued. Gauges were established at Browns Ferry, Robinsons Landing, Wingos Landing, the angle of the dam, and near the Milton Bluff Landing in the canal. Their zeros were referred to the zero of the gauge at the pier opposite the bluff, outside of the canal.

Soundings were taken on lines 100 feet apart and at intervals of 25 feet from Browns Ferry to near Willards Chute, where the water is deep and the bottom comparatively regular. Below this, wherever there was shoal water, soundings were taken closer, sometimes the lines were only 50 feet apart and at others 100. Isolated rock and reefs were located, and extra soundings taken and located by stadia lines. Precaution was taken to fix as accurately as possible every obstruction, and points likely to be of service in estimating the material which might require removal, and that they might be relocated when necessary.

There are seven sheets accompanying this report showing the work done and the position of the bars and reefs better than I can describe them. The low-water marks were determined for each gauge by referring them to the pier gauge, the zero of which I have been told is the lowest water ever known here. The method of reducing the gauge readings to low water is shown by diagrams on the maps. The gauge readings reduced to low water are also shown for each gauge for the months of September, October, November, and December, 1892. From data thus obtained a low-water line was established from Browns Ferry to Lock A, and the estimates were based upon this low-water line.

The bottom of the river is solid rock from station 44, where the excavation must begin for 5-foot navigation, all the way to Lock A. By the line proposed, and which is drawn on the map, the excavation for 5-foot navigation would commence opposite station 44 and end opposite station 344, a distance by the shore line of 30,000 feet, and only 29,000 feet by the proposed center channel line. This excavation will not be continuous, as the profile will show, but will extend over part of seven sections. The amount of excavation on each mile section is shown in the table below for both 6-foot and 4-foot cutting.

	For 6-foot cut.	For 4-foot cut.
	Cubic yards.	*Cubic yards.*
First mile	7,075.5	119.4
Second mile	7,278.7	....
Third mile	88,375.3	40,116.7
Fourth mile	126,778.4	69,505.4
Fifth mile	79,970.7	34,010.5
Sixth mile	146,322.8	87,655.3
Seventh mile	42,806.4	13,978.4
Total	498,607.8	245,385.7

The rock is hard stratified limestone, the strike being diagonally across the river, and the strata lie nearly horizontal. The current cutting across these strata has worn the softest places into holes and left the hardest part in ridges and irregular-shaped reefs. The alignment of the proposed channel has been made with a view to avoiding all difficult curving and change of course, at the same time taking advantage of the best water where it can be done without detriment to the alignment. From the beginning of the cut opposite station 44 to the end opposite station 344 there are only 8 curves, aggregating 7,250, or 25 per cent of the total length, the straight lines aggregating 21,750, or 75 per cent of the total length of the cut. None of these curves has a less radius than 6,000 feet, i. e., 58-minute curve, and are so gentle that I do not think they would be objectionable. The following table gives the alignment on the center line of the proposed channel, commencing at 0 opposite station 44:

Station.	Length of tangent.	Length of curve.	Bank.
0	....	....	
24+70	2,400	....	
36+70	....	1,200	Left.
50+50	1,380	....	
62+50	....	1,200	Right.
93+50	3,100	....	
105+50	....	1,200	Do.
113+80	830	....	
121+80	....	800	Left.
138+50	1,670	....	
144+50	....	600	Right.
168+50	2,400	....	
171	....	250	Left.
190+50	1,950	....	
202+50	....	1,200	Do.
252	4,950	....	
260	....	800	Right.
290	3,000	....	
Total	21,750	7,250	

In estimating the cost of excavation two estimates were made, one for a depth of 6 feet, to give 5 feet navigation, and one for a depth of 4 feet, to give 3 feet navigation. The width of both cuts was taken at 150 feet. Mr. S. B. Williamson, who was in charge of the party in the field, drew the maps and profiles and made out the estimate of the number of cubic yards of excavation required.

The following is the estimate of cost:

For 6 feet depth of cutting, 5 feet draft of boat, 498,608 cubic yards, at $6..	$2,991,648
For 4 feet depth of cutting, 3 feet draft of boat, 245,386 cubic yards, at $6.. ·	1,472,316

In compliance with your instructions I have estimated for a lock and dam to be substituted for the excavation estimated above, as follows:

1. I would suggest building a lock similar to Lock A near the upper end of the quarry at Milton Bluff, and close the present canal by a dam connecting with the wing wall of this lock, extending across to the present dam. I would then suggest building a wooden and stone dam combined from the junction of the cross dam and present longitudinal dam to Browns Island, following the old dam to the point now known as the "angle of the dam," and thence straight to the lower point of Browns Island; or I would follow the old dam, as may be determined hereafter by a closer examination of the bottom, to a point opposite station 318 + 50, and then run it directly to Browns Island. I would thus utilize the old dam from the lock to station 318 + 50, a distance of 2,160 feet, and build a new dam 1,490 feet to the outer angle of the present dam. From this point I would again utilize the present dam, a distance of 2,540 feet, to Browns Island.

As this work was not provided for in the allotment made for the survey, no soundings were taken beyond the present dam. I however took some soundings along the line from opposite the quarry in a direct line to Browns Island, a distance of 6,030 feet. I also sounded from the outer angle of the dam on a continuation of the dam from Browns Island to the longitudinal dam, striking the latter at a point 2,160 feet above the quarry or proposed location of the lock. I find it practical to build a dam on either of these lines; but I consider the last one, which is located along the present dam, except for a distance of 1,490 feet, where it cuts across the angle of the dam, the most practicable, and believe it will be the cheapest, although it is 160 feet longer. The present dam is of so long standing and has become so well settled and firm that I believe, by a judicious arrangement of timber and broken stone, it can be made tight. The exact location of this dam and the plan for building it can be determined hereafter.

The low-water mark in the canal is at reference 484.55. The high-water mark of 1886 at the pier gauge was at reference 493.17, and is the highest water I can find any record of in this office.

By referring to the maps and profiles accompanying this report, you will note that I propose to locate the lock near station 341, and suggest the following references for the new lock, which must be a guard lock:

For the top of the guard wall	500.00
For the lock walls between gates	497.00
For the lower miter sill	478.50
For the upper miter sill	482.50
For the top of the dam across to Browns Island	491.00

I would then suggest tightening the longitudinal dam and raising it for about 2,900 feet below the upper end of the guard wall of the new lock, commencing at the cross dam with a reference of 493.20, and ending with reference 492, the present height of the dam at that point. This would be an increase in height of 4.2 feet at the upper end, and 0 at the lower end, or an average of 2.1. This would prevent the water from getting into the level between the new lock and Lock A, unless it should rise higher than it did in 1886. Should such a rise occur, the water would be higher than the main walls of Lock A, and some changes would be required at Lock A in order that the lock might be used at such a stage of water. As, however, such rises are very rare, and the river would be navigable outside of the canal, I see no reason for any such provision. In addition to this I may add that the dam being above 493 at each end, and 492 near the middle, high water would simply back into the canal at this low point, and it is doubtful if it would reach that elevation, as there is considerable fall in the river outside of the canal between the upper and lower point.

I would suggest as reference for the top of the dam from the new lock to Browns Island 491. This would give a depth of not less than 5 feet in Browns Island

Chute at any point along the left bank at low water and dispense with all excavation above the new lock. The estimate would then be as follows:

For a cross dam 230 feet long, rubble, at $20 per cubic yard	$20,700.00
For a guard lock at the quarry	250,000.00
For 2,900 linear feet of dam raised 2.1 feet, 17,185 cubic yards, at $2	34,370.00
For a dam 6,190 feet long to Browns Island (wood and stone), at $22	136,180.00
	441,250.00
Add 25 per cent for engineering and contingencies	110,312.50
Total	551,562.50

I inclose a tracing of a plan for a dam which I think could be readily adapted to the varying depths of water. The dam across the canal I would build of stone entirely, "squared rubble uncoursed," laid in cement.

Very respectfully,

W. G. Williamson,
Assistant Engineer.

Capt. Geo. W. Goethals,
Corps of Engineers, U. S. Army.

Note.—The elevations given in Mr. Williamson's report and on his maps can be referred to the datum of the survey of 1899 by adding 54.31, and to the mean level in the Gulf of Mexico by adding 41.47.

G. T. N.

February 5, 1901.

Exhibit No. 9a.

REPORT OF LIEUT. GEORGE W. GOETHALS, CORPS OF ENGINEERS, TO THE CHIEF OF ENGINEERS, ON THE SURVEY OF GUNTERS REEF, TENNESSEE RIVER.

Florence, Ala., *October 18, 1891.*

General: I have the honor to forward herewith, in separate package, tracing of Gunters Reef, Tennessee River, and to submit the following project for the improvement of the channel through this obstruction.

The river in this locality is divided by Gunters or Henrys Island, which is about 3 miles in length. The left channel, used to some extent in high water, is during the low stages a slough, about 125 feet wide, fed not only by the river, but by three creeks which empty into it. Just above this island and directly in the channel are two large rocks, which are dangerous to low-water navigation at night. About midway between the head and foot of the island is Gunters Reef, composed of a ledge of irregular limestone rock, with pockets of gravel and sediment, which crosses the main channel obliquely, acting in the nature of a dam and causing an abrupt fall of 0.75 foot in a distance of 600 feet.

The present channel is close to McKees Island, and is narrow, crooked, and very difficult to navigate during the low-water stages in consequence of the reef, and the gravel and sand bars above and below.

The approved project for this portion of the river contemplates 3 feet of water at the lowest stage, and to secure the requisite depth at this locality, and to extend the fall over a greater distance, requires the excavation of the ledge. For miles above and below the obstruction the depth is from 4 to 5 feet. The width of the necessary channel is taken at 120 feet, or four times the width of the largest boat navigating this portion of the river.

From the configuration of the river, the natural position of the channel would seem to be along the left bank, but here the reef broadens out and the amount of excavation required would be greatly increased. The choice of location for the proposed channel lies between the center, as indicated on the tracing, and the widening and straightening of the channel now in use, and the center one is proposed, for the reason that the amount of excavation, being about the same in the two cases, the work can be prosecuted without interfering with the navigation, and there will be less probability of sand and gravel bars forming below after the completion of the work. Should more water be desired after the excavation is finished, submerged crib dams could be used to cut off the water now passing through the sloughs.

It is therefore recommended that the obstructing rocks in the channel above Gunters Island be removed; that Gunters Reef be excavated to a depth of 3 feet below extreme low water, and for a width of 120 feet; that the sum of $4,000 of the $50,000 allotted from the river and harbor act of September 19, 1890, for that portion of the river between Chattanooga and Decatur, be used for this purpose, and that the work be done by contract, that method being considered the most advantageous and economical to the Government.

Estimate.

710 cubic yards under-water excavation, at $5 per cubic yard	$3,550
Engineering and contingencies	450
	4,000

Very respectfully, your obedient servant,

GEO. W. GOETHALS,
First Lieutenant, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Approved, October 20, 1891.

EXHIBIT No. 9b.

REPORT OF MR. D. L. SUBLETT, ASSISTANT ENGINEER, ON SURVEY OF GUNTERSVILLE REEF.

CHATTANOOGA, TENN., *September 18, 1891.*

SIR: I herewith submit a report on the survey of Guntersville Reef, at Guntersville, Ala., with maps and project for improving the same for navigation.

After completing a survey of Bridgeport Bar, I transferred the party to Guntersville on August 25, and the next day began running the shore lines. Before the shore lines were completed the river began rising steadily, and rose to some 7½ to 8 feet above low water, so that it was not until September 1 soundings could be taken.

About 3 miles above Guntersville Landing the Tennessee River divides, the left channel being a slough about 125 feet wide, and forms a large island, known as Gunters or Henrys Island. Three large creeks enter this slough, and it discharges again into the main channel at Gunters Landing.

Just above the head of this slough are two interfering rocks directly in the channel; so it was thought best to begin the survey at the head of the slough, so as to show completely the division of the river and also these interfering rocks, as I was enabled to determine to a very close approximation low-water surface by taking levels on them. About 76 stations below the head of the slough named, the river again divides, forming another island known as McKees, to the right of the main channel. A transit line was also run along the left bank of this island from its head to the foot.

About midway this island, and crossing the main channel angling downstream, is a limestone rock reef, known as Gunters Reef.

The water, at extreme low stages for several miles above and below, is from 4 to 5 feet deep. The fall here at low stages is abrupt and is about 9 inches, and the channel, which is close into McKees Island, is narrow, crooked, and difficult to navigate at low stages, there being sand and gravel bars extending out from the island above and below the fall.

From the configuration of the river at this point, the natural position of the channel would seem to be on the opposite side, or left bank, but here the reef widens and is flat and about 1½ to 2 feet at low water.

The river at the time soundings were taken being still some 5 feet above low water, it was thought best to stretch a wire rope across the channel above the reef where the water was sufficiently deep, and then, by means of another line attached to the first and a skiff to drop down every 25 feet, triangulate the point and take levels on the rod as well as soundings. In this manner I was enabled to procure a very full and accurate contour of the river bed embraced by the reef.

The high-water elevation was found for 1875 to be 44.163 feet above assumed low water at a stone marked "H. W." 1875, on road to Guntersville, elevation of high water above sea level being 600.163.

An elevation of 564 feet above sea level was assumed as the elevation of water surface at the initial point of survey, and approximate low water was as taken from the rocks named, and given by Mr. J. I. Thompson and Captain Capehart, an old river pilot, who lives near this point, and was found to be 559.75 at the lowest stage ever known. It was impossible to obtain definite low water below the reef, but from the best information I could obtain the fall here at extreme low water is about 9 inches, and is abrupt.

To make a channel on the left side would require much rock excavation. It is, therefore, believed that the best channel can be had either next to the right bank by removal of the narrow projecting reef from series C to G, or from K to O. The usual plan to determine the width of channel is to take four times the width of the boats navigating the stream. As the largest boats on this river have about 30 feet width, I have estimated for a channel 120 feet wide, with 3 feet at extreme low water.

The center channel, in my opinion, will be the best as regards location, but the shore channel will be less expensive by reason of the fact that the water can be managed better nearer the bank during the work. If the center channel is adopted, the work could be done probably without interference to navigation, and there would be less probability of sand and gravel bars forming below.

If found necessary, either one or both of the channels at the head of McKees Island could be closed after the improvements contemplated are made by submerged cribs filled with stone.

The following is an estimate of work to be done at Gunters Reef for a channel 120 feet wide and 3 feet deep at extreme low water.

As it will be necessary in blasting to take out much more rock than is actually required, I have estimated for 1 foot average for 150 by 120 feet, though between the ledges much of the material is gravel, which, when the ledges which now hold it in position are removed, will wash away.

Estimate.

710 cubic yards of under-water rock excavation, $5	$3,550.00
Engineering and contingencies, 15 per cent	553.25
Total	4,103.25

In similar work as the above on this river where all the plant was on hand, and labor about the same as now, I excavated in channel 12,000 cubic yards of limestone rock at an actual cost of $2.17 per yard, including every item of expense, the drilling being done by hand, and the stone boated several thousand feet. The material here can be disposed of close at hand, or used to close the lower slough at head of McKees Island, through which water passes to the other channel.

Respectfully submitted.

D. L. SUBLETT,
Assistant Engineer.

Lieut. GEO. W. GOETHALS,
Corps of Engineers, U. S. A.

EXHIBIT No. 9c.

REPORT OF CAPT. GEO. W. GOETHALS, CORPS OF ENGINEERS, TO THE CHIEF OF ENGINEERS, DATED AUGUST 5, 1892.

FLORENCE, ALA., *August 5, 1892.*

GENERAL: I have the honor to forward herewith a tracing in two sheets of the channel around Bridgeport Island, Tennessee River, the improvement of which is contemplated in the project approved August 1, 1892, and to respectfully recommend the following method for its improvement:

Bridgeport Island, 4.7 miles long, divides the river in two portions. The left-hand chute, or steamboat channel, has a width of from 400 to 500 feet, while the right chute is from three to four times this width. The right-hand chute is closed by flat rock reefs extending from the head of the island to the bridge, which are covered with very little water during the lower stages and which prevent navigation to Bridgeport. The draw of the railroad bridge crossing at Bridgeport, and which has recently been enlarged and rebuilt, is over the left-hand chute. These considerations, in addition to the greater amount of excavation that would be required in the right-hand chute over that in the left, led to the survey of the channel or left-hand chute only.

There are three bars in the channel which obstruct navigation. The first, near the head of the island, is about 700 feet in length, consisting of a few projecting rock ledges and gravel; the second is just above the bridge, mainly of rock, about 1,100 feet in length; and the third, of rock and gravel near the foot of the island and 1,400 feet long. The depth of water on these bars at extreme low water is about 18 inches.

The route followed by steamboats is indicated on the tracing, and this line is taken as the center line of the channel that it is proposed to excavate through the bars above referred to, the channel to have a width of 150 feet and a depth of 3 feet at extreme low water.

In determining the amount of excavation the grade line from the low water at the head of the island (595.25) to the bridge (591.99) is taken with a slope of 0.79 foot to the mile, while from below the bridge to the foot of the island the grade is 0.71 foot per mile, determined from the low-water mark at the head of Widows Bar, 2.5 miles below the foot of the island.

In addition to the excavation, it is proposed to use the material thus obtained in building a wing dam from the head of the island, as indicated in the tracings, to a height of 18 inches above extreme low water, the dam thus built to be extended should it be found desirable to do so after the excavation is completed.

It is further recommended that this work be done by contract.

Estimate.

6,000 cubic yards of rock excavation, at $4 per cubic yard	$24,000
20,000 cubic yards of dredging, at 35 cents per cubic yard	7,000
	31,000
Superintending and contingencies, 10 per cent	3,100
	34,100

Very respectfully, your obedient servant,

Geo. W. Goethals,
Captain, Corps of Engineers.

Brig. Gen. Thomas L. Casey,
Chief of Engineers, U. S. A.

Exhibit No. 9d.

ESTIMATES FOR IMPROVING THE LEFT CHANNEL AT BRIDGEPORT ISLAND AND WIDOWS BAR, TENNESSEE RIVER, MADE BY MR. D. L. SUBLETT, ASSISTANT ENGINEER, IN JULY, 1892.

Estimate for improving the left channel at Bridgeport Island.—The estimate for this work is based on low water above the bridge as being 593.223, and at the head of the island as 595.50, and at the lower obstruction below the bridge as 591.99. In estimating for this work the center line of the channel was first carefully laid off on the map, and the average of the soundings was taken at every point to a width of 75 feet on each side of the center line from the head of the island to the bridge and below the bridge 60 feet each side of the center line. A grade line of seventeen-hundredths per 1,000 feet, or 2.3 feet in 136 stations, was taken from the head of the island to the low water above the bridge, and the grade below as fifteen-hundredths per 1,000 feet.

On this basis there is 3 feet of water at the lowest stage, except at the following points:

From station 0 to 17 the average excavation is seven-tenths, and all gravel. From station 90 to 139 the average excavation is seventy-three hundredths, with projecting rocky points, except first above the bridge, where the rock seems to be flat or nearly so.

From station 151 to 156 average excavation six-tenths, mostly logs and gravel.

From station 214 to 236 the average excavation is six-tenths, and is rock and gravel.

This work, so far as solid-rock excavation goes, can be done comparatively cheaply if a tripod dam that will stand a rise of 3 feet is erected across the head of the island and all the water turned to the right channel.

I would recommend that the channel at the head of the island be excavated by dredging 4 feet below low water and full 150 feet wide, so as to draw in the water to this channel. This would increase the depth throughout without any other excavation, as it would flatten the fall, which is already slight, and increase the volume very much.

All material should be dumped in deep water either above or below the island. If found necessary the right channel could be contracted by a wing dam, and the material excavated could be used for this purpose.

The following is the estimate for this work by contract:

Total material to be excavated above the bridge for a 3-foot channel 150 feet wide is 25,912 cubic yards.

4,500 cubic yards solid rock excavation, at $4		$18,000
22,000 cubic yards dredging, at 35 cents		7,700
		25,700

Below bridge.—Total to be excavated for a 3-foot channel 120 feet wide, 6,600 cubic yards:

1,500 cubic yards solid rock, at $4	$6,000	
5,100 cubic yards dredging, at 35 cents	1,785	
Engineering and superintendence	3,348	
		11,133
Total		36,833

Widows Bar.—Mr. J. I. Thompson, who is very familiar with this obstruction, informs me that with 10 men working two weeks he could easily give 12 inches more water at this point, but beyond this will require much work. I therefore estimate that to give 12 inches more water at this point will require—

150 cubic yards solid-rock excavation, at $4	$600

As the bar is a considerable barrier to navigation at low water by reason of the narrow channel and projecting points, and the cost to give 12 inches more water slight, it seems that this work should be done this season.

Respectfully submitted.

D. L. SUBLETT,
Assistant Engineer.

EXHIBIT No. 10.

EXTRACTS FROM THE ANNUAL REPORTS OF THE CHIEF OF ENGINEERS, CONCERNING THE IMPROVEMENT OF THE TENNESSEE RIVER BETWEEN CHATTANOOGA AND MUSCLE SHOALS CANAL.

[Annual report 1892, pp. 1946–1947.]

Bridgeport bars.—There are three bars in the vicinity of Bridgeport, Ala., any one of which is an obstruction to navigation. The river at this locality is divided by Bridgeport Island, the channel on the left being the steamboat route. Near the head of the island is the first rock reef, about 700 feet in length, on which there is a minimum depth of 1 foot at extreme low water. The second obstruction is just above the railroad bridge, also rock ledges, about 1,100 feet in length, with depth of water at lowest stage of 18 inches; this depth covers the third rock reef, near the foot of the island, which is 1,400 feet in length.

Widows Bar.—This obstruction, another rock reef, is about 2.5 miles below Bridgeport Island, and is about 2,800 feet in length, the depth of water varying from 1.5 to 2.5 feet.

Guntersville Bar.—The river just above Guntersville is obstructed by bowlders and loose, detached rock, which make the steamboat channel very crooked and difficult of passage during low-water stages, and by a rock ledge 300 feet long on which there is a minimum depth of 1 foot of water.

Other obstructions of minor importance exist between Guntersville and Decatur, but their exact nature and extent are not known, as a survey of this portion of the river has never been made.

The approved project for this section of the river is "to remove obstructions, so as to secure a depth of at least 3 feet at low water," and $50,000 of the appropriation of September 19, 1890, was allotted "to be expended in removing bowlders by blasting, cutting trees from the banks, and dredging at and between the localities known as Tumbling Shoals, "Suck," "Pot," and "Skillet," in the mountains below Chattanooga, and in channel excavation at Bridgeport and Guntersville, Ala."

The following work has been done during the past fiscal year: The survey, begun in May, 1891, was completed to Kellys Ferry, about 23 miles below Chattanooga; surveys were made of the Bridgeport, Widows, and Guntersville bars; total length of surveys, 32 miles. The maps of all the obstructions have been platted.

* * * * * * *

A contract was entered into December 11 with Neely & Smith, of Chattanooga, Tenn., the lowest bidders, for excavating a channel 150 feet wide through the reef at Guntersville, and for the removal of obstructing bowlders near the head of Henrys Island. The contractors prepared the necessary plant for commencing the work, but the river rose and has not been sufficiently low since to enable the work to be done.

[Annual report 1893, p. 2422.]

The project of improving the channel near Bridgeport consisted in excavating and dredging, so as to give an increased depth of water.

Proposals to do this work were invited by advertisement, and bids were opened September 15, 1892. The project for the expenditure of the appropriation of July 13, 1892, had been submitted prior to the enactment of the eight-hour law of August 1, 1892. The limitation of the hours of labor required under the law so increases the cost of the contemplated work at Ross Towhead, Tumbling Shoals, and Bridgeport that it can not be accomplished with the means available. When the bids for Bridgeport were opened they were found to be greatly in excess of the estimate, and on recommendation they were rejected. The Government being in possession of the requisite plant to do the work by hired labor, this method was authorized as most economical and advantageous.

Work was accordingly begun in October. A temporary tripod dam 512 feet long and from 7 to 12 feet high, similar to that used at Tumbling Shoals, was thrown across the channel at the head of the island to facilitate drilling and blasting; 1,274 feet of holes were drilled, about one-third of which had been fired, when an unexpected rise occurred in November, causing a suspension of the work. Since that time the water has not been at a sufficiently low stage to resume drilling. In December the United States dredge *Harwood* was transferred from the Muscle Shoals Canal to Bridgeport and worked until stopped by ice and high water. This enforced stoppage offered an opportunity to construct a new hull and transfer to it the machinery of the old dredge. In June dredging was resumed and was still in progress at the close of the fiscal year. The quantity of material removed up to that date consisted of 248 cubic yards of rock, 1,544 cubic yards of gravel, and 896 cubic yards of clay. Miscellaneous work consisted in preparing temporary shelters for men, blacksmith's forge, dynamite, subsistence and other stores, and in repairing plant.

At Guntersville, under contract with Neely & Smith, operations were begun in the fall of 1892. After the removal of 715.8 tons of rock work was interrupted in November by a sudden rise in the river, and the plant had to be transferred to a place of safety. The river has not since been at a favorable stage to resume operations. The time for completing this contract was extended to November 1, 1893.

The Nashville, Chattanooga and St. Louis Railway Company, desiring to run a transfer boat from Guntersville to Hobbs Island, a distance of about 23 miles, made a request for the clearing out of the gap above referred to as existing in Beards Reef. A preliminary examination was made, upon the result of which it was recommended that the obstructing rocks in the gap be removed, the cost not to exceed $600. The recommendation being approved, 20 cubic yards of rock were removed and 10 cubic yards so broken up as not to interfere with navigation. The channel through the gap is now straight, 120 feet wide, and 3 feet deep at low stages.

[Annual report 1894, pp. 1823-1824.]

The improvement of the channel at and near Bridgeport by hired labor was prosecuted until well in the fall, when high water made removal of plant necessary. From the bar at the head of the island there were removed 21,512 cubic yards of sand and gravel, resulting in a completed channel 120 feet wide and averaging about 6 feet deep. This increased depth was given to allow for drawing off the water that will result when the bars below and in the same chute are removed. Through the bar above the railway bridge only one cut was made by the dredge when operations were suspended. There were removed 1,590 cubic yards of loose rock and 5,920 cubic yards of other material, principally clay. The channel formed here has a total length of 1,800 feet, width 40 feet, depth 5 feet.

The contract with Neely & Smith for removing material at Gunters Reef was extended to November 15, 1894, the contractors having been unable to do any work owing to sudden and frequent fluctuations in depth of water, which resulted in twice washing out their temporary tripod dam before any work could be done. This dam was used to deflect the current so that the men could stand on the river bottom to drill. On application of contractors and by authority of the Chief of Engineers, they proposed to complete their contract by the aid of a United States dredge not in use, making a reasonable allowance for same. The dredge was started to that locality the last of June.

[Annual report 1895, pp. 2289, 2290, 2291.]

Reefs opposite Bridgeport, Ala.—Work was resumed here in November, 1894, and continued until the close of this fiscal year, with many interruptions due to cold weather and too high a stage of water.

The obstructions are gravel and bowlders, and the project is to dredge these out to form a channel 120 feet wide and 3 feet deep at low water.

The work done in 1893–94 was suspended before all the bowlders found were removed from the channel.

During 1894–95, 200 of these bowlders, amounting to 64 cubic yards, were removed, some of them requiring to be drilled and blasted.

This work cost $266.57, or $4.16 per cubic yard.

The material dredged in 1893–94 had been dropped by the dredge outside of the cut, and this in 1894–95 was rehandled and placed outside the proposed channel as the foundation of a projected longitudinal dam intended to confine the water to the narrow dredged channel and also to back the water up the chute, the conditions of slope permitting this to be done. This double handling of the material dredged seems to be the cheapest way to do the work, for proper plant is not available for carrying the bowlders and gravel excavated at once to their place. The excavation was found to be of the most difficult kind, the gravel being filled with huge bowlders, which strained and often broke the dredge machinery, necessitating constant delay and repairs.

Mr. W. S. Winn, the assistant engineer in charge, showed great perseverance under the frequent annoying rises of the river, which suspended work, and the intense cold of the latter part of December and of January. The presence of these bowlders also necessitated dredging to more than the otherwise required depth in order to remove them.

Three thousand and three cubic yards of bowlders and 4,578 cubic yards of clay, sand, and gravel were dredged during the fiscal year, at an average cost of 35 cents per cubic yard for rock and gravel combined.

The accomplishment of the above dredging involved a great deal of repairs to the dredge, which is really too light for such heavy work. The dipper handle broke, spuds had to be renewed, and great difficulty was experienced in getting timber long enough for these repairs. The maneuvering chains had almost daily to be repaired, owing to the violent shocks sustained.

A few snags were also removed from the channel at this point, also a sunken barge, at a cost of $27.80.

Island Bar.—By September 13, 1894, the necessary boats had been brought up from Muscle Shoals Canal and work begun at Island Bar. This is 1.5 miles below the Bridgeport bridge, and extends half a mile downstream across both chutes. In the left-bank chute the obstruction is solid limestone reef, crossing the chute at an angle, and about 600 feet across, up and down stream. Below this are bowlders, sand, and gravel.

The project is to excavate a channel 120 feet wide and 3 feet deep at low water.

A tripod dam 180 feet long, in 15 bays, was used to break the force of the current, and was moved four times as work progressed.

Eight hundred and eighty-nine and seven-tenths cubic yards of solid rock and 21 cubic yards of gravel were excavated by drilling and blasting, and removed by wheelbarrows, at an average cost of $4.16 per cubic yard for rock and gravel combined.

A channel 80 feet wide and 2 feet deep at low water was obtained for the distance of 600 feet. This gave 12 inches more depth of water over the reefs than ever before, and 4 inches more over the reefs than over the gravel bar below.

In the right-hand chute, on the other side of Bridgeport Island, the rock reefs appear again at seven distinct spots within a channel length of 200 feet. Each reef is about 6 feet thick, and between the reefs the water is deep enough. Thirty-five cubic yards of rock were removed, at an average cost of $4.16 per cubic yard, and 390 overhanging trees were cut, at an average cost of 12½ cents per tree.

Work here was stopped November 1, 1894, owing to the coldness of the water.

Guntersville Bar.—Slow progress was made with the dredge, however, which was the same one used later at Bridgeport, as described above. The difficulties of the work were the same as described above for Bridgeport. The dredge was abandoned, and by November, 1894, the water had become too cold for laborers to stand in, and work here was abandoned by the contractors.

Beards Reef.—A small force was put to work at the end of October, 1894, to remove points of reef and bowlders and give relief to transfer steamboats. A tripod dam 30 feet long was used to deflect and break the force of the current while men worked in the water. This was moved twice as work progressed, and four times to allow the passage of boats.

Sixteen cubic yards of bowlders, one large bowlder not measured, and two logs were removed from the channel, at a total cost of $211.05.

[Annual report 1896, pp. 1929, 1931, 1932, 1933.]

The total amounts expended on this section of the river since July 1, 1891, are as follows:

Locality.	July 1, 1891, to June 30, 1895.	Year ending June 30, 1896.	Total for five years.
* * *	* *	* *	* *
Bridgeport, Ala.	$37,490.04	$9,144.20	$46,634.24
Guntersville and Beards Reef	3,463.52	3,621.14	7,084.66

Bridgeport Reefs.—The obstructions are gravel and bowlders, and the project is to dredge these out to form a channel 120 feet wide and 3 feet deep at low water, and to make of the dredged material a longitudinal dam intended to confine the water to the narrow dredged channel, and also to back the water up the chute. The excavation was found to be of the most difficult kind, the gravel being filled with large bowlders, which strained and often broke the dredge machinery, necessitating constant delay and repairs.

All the work has been done by hired labor, using the U. S. dredge *Harwood*, which is really too light for such heavy work. At the end of the first week in July the dredge broke down and was ordered to Muscle Shoals Canal for repairs, and before repairs could be finished the river had become too low to get it back. Nearly the whole working season was therefore lost, for it was not until January that a rise occurred sufficient to get the dredge back up the river. En route the dredge stopped to do some work at Flint River Bar, reaching Bridgeport in February. Only a few days' work was accomplished before high water compelled the tying up of the fleet. The dredge was again brought out on May 22 and worked continuously to the end of the fiscal year, except for a period of ten days, during which a new "A" frame was being erected and a new dredge dipper being made. One thousand four hundred and twenty-one cubic yards of bowlders and 3,104 cubic yards of clay and gravel were dredged from the channel, at a total cost of $1,318.76, or 29.2 cents per cubic yard. At the close of the fiscal year there remains about two more weeks' work for the dredge and derrick boat at this point. At the end of this time the channel at Bridgeport Bar will be 100 feet wide and 3 feet deep for a distance of 1,400 feet upstream from the bridge, except for a distance of 100 feet immediately on the reefs, where there will be at least 2½ feet at low water.

Island Bar.—During the fiscal year ending June 30, 1895, 889.7 cubic yards of solid rock and 21 cubic yards of gravel were excavated by drilling and blasting and removed by wheelbarrows, at an average cost of $4.16 per cubic yard for rock and gravel combined.

A tripod dam 180 feet long, in fifteen bays, was used to break the force of the current, and was moved four times as work progressed. This work has resulted in a channel 80 feet wide and 2 feet deep at low water for a distance of 600 feet, which is 12 inches more depth of water over the reefs than ever before. During the fiscal year no work was done, the fleet being engaged at worse obstructions.

Gunters Reef.—In August, 1895, the United States fleet, consisting of the steamer *McPherson*, derrick boat, three barges, and two cabin boats, were taken from Bridgeport to Gunters Reef and the work continued by hired labor. A tripod dam 160 feet long was put in, and notwithstanding a delay of nearly three weeks on account of a rise, very good progress was made.

The contractors' greatest trouble had been to get explosives deep enough to do good execution, on account of sand and crumbled pieces of the top ledge filling the holes as soon as the drills were removed. This was overcome by using pieces of 2-inch pipe about 14 inches long. The bit of the first drill was made the same width as the outside diameter of the pipe. The hole was put down about 10 inches, the pipe inserted, and a drill with a bit to fit the inside of the pipe carried the hole down as deep as desired.

The material was easily drilled, a crew of three men drilling 50 feet of holes in one day. The strata were almost horizontal, consisting of rotten limestone, flint, and shale, with here and there pockets of fire clay and iron ore.

The old channel was both crooked and shallow. The project was to cut a straight channel through the reefs with a depth of 3 feet at low water.

Eight hundred and six cubic yards of rock, requiring 2,048 linear feet of hole to be drilled, were removed at a total cost of $2,088.96, or $2.59 per cubic yard, which includes all expenses incurred in preparation and in working at this place.

The result of the season's work is a channel through the reefs 350 feet long, with a depth of 2½ feet at low water for a width of 60 feet and a depth of 20 inches for an additional width of 60 feet. Although the project is not completed, the work done has facilitated navigation, and boats that formerly had to lay lines have since stemmed the current at the same stages of water with barges in tow.

Beards Reef.—The old channel went from about one-third across the stream above the reef to within 100 feet of the north bank at the reef, then with an abrupt bend crossed to the south bank. The project was to cut a straight channel through the reef and bar about 200 feet from the south bank, where the water is deep immediately above and below. The dredge was not available, but it was decided to blast and remove as much as possible of the solid reef with the steam derrick, and to leave the rest to be picked up by the dredge. Work was begun September 21 and continued until early in October, when all the reef that appeared above the gravel had been removed.

Five hundred and one cubic yards of rock, requiring 1,437 feet of holes, were removed and placed along the sides of the excavation at a cost of $1,704.63, or $3.40 per cubic yard. As the rock was of the hardest limestone and pure flint a screw was able to drill only about one-third as much here as at Gunters Reef. Before the new channel can be used the dredge will have to pick up the gravel and other loose material.

Flint River Bar.—This obstruction is about 20 miles below Guntersville, and was formerly the shoalest place between Guntersville and Hobbs Island. The transfer boat of the Nashville, Chattanooga and St. Louis Railroad Company always had difficulty here when the low-water season began. It was thought to consist entirely of loose material brought in by Flint River, but was later found to be underlaid by a rock reef. The dredge *Harwood*, en route to Bridgeport, worked here from January 7 to January 25, 1896, when high water caused a suspension of the work.

Ninety-two cubic yards of bowlders and 2,906 cubic yards of clay and gravel were dredged from the channel at a cost of $785.53, or 26 cents per cubic yard. Two of the necessary four cuts were made with the dredge and a depth of over 3 feet obtained, except for a distance of 40 feet up and down stream, which will require blasting.

[Annual Report 1897, pp. 2255, 2256, 2272, and 2273.]

After the river passes the mountains its character changes, and from thence down to Decatur the river is generally wide and shallow with a gentle slope. The obstructions are broad, flat bars, sometimes composed of solid rock, but more often of hardpan, in which large bowlders are embedded; at other places the obstructions are rock reefs. The veins of blue flint which were embedded in the rock which forms the bottom of the channel have been exposed by the erosion of the softer rock adjacent until they stick up a foot or more above the general level of the bottom. They are usually inclined, but sometimes nearly vertical. They can be blasted off and a limited improvement thus obtained.

The United States dredging plant, consisting of the stern-wheel towboat *McPherson*, the *Harwood*, an Osgood dipper dredge, a 12-horsepower steam derrick boat, and four barges, were employed during the greater part of the season upon the river between the mountains and Decatur. The following work was done:

At Bridgeport, immediately above the drawbridge, 820 cubic yards of rock, clay, and gravel was dredged from the channel, and 285 cubic yards of rock was blasted and removed by the derrick boat. The work, with that heretofore done, forms a channel through this bar 1,400 feet in length, 100 feet wide, and 2½ feet deep in the shallowest portion at that extreme low water.

The greater part of the channel is much deeper than this, the shoal part being due to the existence of some rock which it was not possible to remove, owing to the lateness of the season.

At Widows Bar, 5 miles below the bridge at Bridgeport, there exists an extensive shoal; the length of the shoal water is about 3,000 feet along the channel, but it is crossed near the head by 10 or 12 projecting, flinty reefs, which stick up 12 or 15 inches above the general bed of the river. There is only about 8 inches of water over some of these reefs at the extreme low stages of the river. The excavation of the channel through this entire bar was too great a work to be undertaken at this time, but the reefs were drilled and blasted over a space 80 feet wide and 250 feet long. The broken rock has not yet been removed, but it will be done during the present low-water season, and will to the extent indicated improve the navigation over this bar.

At the head of Henrys Island the channel was very narrow and the current quite swift for this portion of the river. There were two large rocks on one side of the channel and one on the other which interfered with navigation. These rocks were drilled and blasted off so as to afford a sufficient depth over them.

At Beards Reef, just below Guntersville, a channel 120 feet wide and 550 feet long was drilled, blasted, and dredged completely through the reef, thus giving a channel 3 feet in depth at extreme low water. Nearly 10,000 cubic yards of material was dredged from the cut and 190 cubic yards of solid rock was removed with the derrick. This work was very severe on the dredge; some very large pieces of stone were handled by it; one piece weighing nearly 25,000 pounds was brought up and swung out of the channel.

At Flint River Bar, just below the mouth of Flint River, the channel has been changed so as to avoid a very bad crossing. Work had been done at this place in the previous year.

A great deal of drilling and blasting has been done. Dredging was done during the past year so as to afford a channel having a minimum width of 60 feet and an average width of 120 feet, with a depth of 3 feet at extreme low water. A small place, about 30 by 60 feet, was not given the full depth for the width of 120 feet, because the rock was not sufficiently broken up by the previous blasting to enable the dredge to remove it.

From the foot of Beards Island to Browns Ferry, a distance of 105 miles, the river has never been surveyed, and no complete plan has ever been made for its improvement, and no estimate of the entire cost necessary to give a 3-foot navigable channel at extreme low water over it has ever been made. Of course it is impossible to make an estimate without a survey.

For details of the work done on this portion of the river, for general cost of the same, and the unit prices I would respectfully refer to the report of Assistant Engineer W. S. Winn, who was in local charge of the operations.

Exhibit No. 10a.

REPORT OF MR. W. S. WINN, ASSISTANT ENGINEER, ON WORK AT BRIDGEPORT ISLAND.

Chattanooga, Tenn., *June 1, 1895.*

Captain: I have the honor of making herewith report of the work done under my supervision on the Tennessee River below Chattanooga between July 1, 1894, and May 31, 1895.

Work was done at Gunters Reef, Beards Reef, and Flint River Bar, and at Bridgeport, as follows:

GUNTERS REEF.

Several attempts to excavate a channel by drilling and blasting and removing the material by hand having failed, the contractors, Neely & Smith, leased the U. S. dredge *Harwood* and outfit for the purpose of removing with it the material already blasted. The steamer *McPherson* left the Muscle Shoals Canal with that outfit in the latter part of June and arrived at Gunters Reef July 4. The contractors concluded, after a trial, that the dredge was not equal to the work, and accordingly abandoned the project, returning all of the outfit to the Muscle Shoals Canal except the dredge, which was received from them at Guntersville and left in charge of a watchman.

BEARDS REEF AND FLINT RIVER BAR.

A force of one foreman and seven laborers was taken from Bridgeport to Beards Reef on September 25 to remove the points of the reef and bowlders that projected above the gravel bed of the river. The object of the work was to give temporary relief to the Nashville, Chattanooga and St. Louis transfer boats and others plying that district until plans for permanent improvement could be adopted.

A tripod dam 30 feet in length was put in to break the force of the current. The dam was removed twice to cover different portions of the work, and four times to allow the passage of boats. The work accomplished was as follows:

Twelve cubic yards of rock were blasted from the reef and removed to near the right bank. Seven bowlders in the channel just below the reef were blasted, and the pieces aggregating 4.5 cubic yards were removed from the left bank. One large bowlder at the mouth of Browns Creek was blasted off into the deep water surrounding it. Two logs were removed from the channel.

The force was then taken to Flint River Bar, but careful examinations by men wading in the water failed to reveal any rock projecting above the bed of the channel.

The total cost of the work, including cost of transportation of the men and outfit, and cost of examinations at Flint River Bar, was $211.05.

BRIDGEPORT.

Work under the head of Bridgeport was done at three different places, as follows:

Island Bar.—This bar is in the left slough of the river 1¼ miles below the Nashville, Chattanooga, and St. Louis Railway drawbridge, and extends half a mile down the river. The obstruction consists of solid limestone reefs crossing the river slightly upstream from the island to the left bank. The reefs extend from the head of the bar 600 feet downstream, and the bar below consists of sand, gravel, and bowlders.

The project for this work was to excavate a channel 120 feet wide, and have a 3-foot depth at low water; and in doing this, to follow the old channel as nearly as possible. The old channel lay in close to the left bank over the reef, and below approached nearer the center of the slough.

Orders were received September 2 to bring a plant from the Muscle Shoals Canal and proceed with the work. The steamer *McPherson*, after undergoing necessary repairs at the canal, reached Bridgeport with the fleet September 13, and work began at once. A tripod dam 180 feet in length was put in from the left bank to break the force of the current, and was moved four times during the prosecution of the work. The work was abandoned November 1, the following work having been accomplished:

Eight hundred and eighty-nine and seven-tenths cubic yards of solid rock and 21 cubic yards of gravel were excavated by drilling and blasting and removed on wheelbarrows to near the left bank and deposited along the line of the excavated channel.

A channel 80 feet wide and 2 feet deep at extreme low water was thus excavated for a distance of 600 feet from station 214 + 50 to 220 + 50 left bank (survey of 1891). This excavation gave 12 inches more depth of water over the reefs than was formerly there, and gave 4 inches more water through the reefs than on the bar below.

Right slough.—The reefs that cause the obstruction at Island Bar appear again on the other side of the island in the right slough as seven distinct reefs within a distance of 200 feet up and down the river. Each reef is about 6 feet thick and between them the water is deep enough. The channel lies in close to the bank of the island. With a view to removing some of the highest points of the reefs and cutting the overhanging trees along the bank a small force was put to work, but was called off at the end of a week on account of the coldness of the water. The following work was done: Thirty-five cubic yards of rock were removed, 390 trees cut.

Bridgeport Bar.—The original project for improving this bar was to dredge out the old channel to a 120-foot width and a 3-foot depth at extreme low water. The excavated material was to be boated to deep water and dumped. Under this project one cut, about 30 feet wide, was made with the dredge in 1893 from station 109, right bank, to 140, left bank (survey of 1891). In doing this bowlders were "nosed up" by the dredge and left with less than 1 foot of water over them at extreme low water. Two hundred of these bowlders, some of them requiring to be drilled and blasted, were hoisted with a derrick and cast upon the bank. These bowlders aggregated 64.1 cubic yards.

From station 132 to 140, left bank, the material dredged in 1893 was simply cast over and left along the outside boundary of the channel. The channel thus left between this bank and the mainland was deemed too narrow for the easy passage of boats. The present project provided that the material in this bank be again cast over toward the island and left to form a side dam to the excavated channel. Also, that a dam be made of the material to be boated from the head of the side dam to the island to catch up the water lost by deepening the channel; to back the water upon the shallow places above, and by thus narrowing the cross section of the channel to one-third the width of the slough, to increase the depth.

The nature of the bottom is such as to render it difficult to be handled with the dredge. Huge bowlders are embedded in the clay and gravel, and to remove them it is necessary to excavate to an average depth of 1.5 feet below subgrade. Experience has shown that it is not practicable to approach the required subgrade within a closer limit. Many repairs to the machinery and a new dipper handle and spuds were required. The following work was done by the dredge: Three thousand and three cubic yards of bowlders excavated, 4,578 cubic yards of clay, sand, and gravel excavated. Of these amounts 957 cubic yards were towed to the line of the proposed cross dam and 6,624 cubic yards were cast over.

Cost of work at Bridgeport, Ala., from July 1, 1894, to May 31, 1895.

Island Bar:	
889.7 cubic yards of solid rock excavated, 21 cubic yards of gravel excavated	$3,787.41
Right slough:	
35 cubic yards of rock removed, $145.57; 390 trees cut, $49.12	194.69
Bridgeport Bar:	
64.1 cubic yards rock removed with a derrick, $266.57; 3,003 cubic yards bowlders dredged, 4 578 cubic yards clay, sand, and gravel dredged, $2,621.87; 1 sunken barge removed, $27.80	2,916.24

The miscellaneous work consisted of repairs to the steamer *McPherson*, towing the fleet, and removal of 1 snag and 1 sunken barge from the channel.

Other miscellaneous work on the division consisted of building 4 skiffs at Chattanooga for the survey below Riverton, drawing plans for quarter boats for the same survey, and making examinations, maps, and reports of the condition of Ross Towhead in August, 1894.

Very respectfully, your obedient servant,

W. S. Winn,
Assistant Engineer.

Capt. Theo. A. Bingham,
Corps of Engineers.

Exhibit No. 10b.

REPORT OF MR. W. S. WINN, ASSISTANT ENGINEER.

Florence, Ala., *June 7, 1897.*

Captain: I have the honor to submit herewith a report of the work done under my supervision on the Tennessee River below Chattanooga for the eleven months ending May 31, 1897.

The plant in my charge consisted of the U. S. steamer *McPherson*, the *Harwood*, an Osgood dredge, 1½-yard dipper, a 12-horsepower steam-derrick boat, 4 barges, and necessary skiffs and other appliances. Work was done at the following shoals: Bridgeport, Widows Bar, head of Henrys Island, Beards Reef, Flint River Bar, Wagon Factory Bars, and Sweetwater Bar—given in their sequence coming down the river. In the estimates of the cost of materials removed there is included the cost of labor, material expended, subsistence, and the repairs incident to the work immediately in hand, other repairs being considered in the nature of a plant. As relates to the dredge, owing to the lightness of the machine for the heavy work undertaken, repairs formed a considerable part of the cost, both for material used and for the time of the crew in making the repairs. March and April and most of July and May were lost on account of high water, and during those times extensive repairs were made to the fleet. The following work was accomplished:

BRIDGEPORT.

Under the project for this place undertaken in 1893 work was in progress at the beginning of the fiscal year, but owing to an unprecedented high stage of the river, dredging was possible for only a few days of the first ten in July. The river still being too high at the last of that month, it was decided to take advantage of the favorable stage to take the dredging outfit to Beards Reef and leave the few remaining days of work at Bridgeport to be done by hand. A steam-derrick boat and a small force of men were employed here in October drilling and blasting and removing from the channel rocks that the dredge had been unable to handle.

The following work was accomplished:

Dredging 820 cubic yards of rock, clay, and gravel, at a cost of 41 cents per unit.

Excavation by blasting and removing with derrick boat, 285 cubic yards of rock, at $2.04 per unit.

When work was abandoned on account of the coldness of the water and a rise in the river, a channel 100 feet wide and 2½ feet deep at the shallowest places at low water had been finished from the bridge, 1,400 feet upstream. The average depth of channel was much greater than this, it being 8 feet deep in many places whence large bowlders had been removed.

WIDOWS BAR.

This obstruction is about 5 miles below the bridge at Bridgeport. The entire shoal is about 3,000 feet long, but the principal obstruction occurs at the head, where some 10 or 12 reefs cross the channel and project 12 or 15 inches above the bed of the river. Here the channel affords only 8 inches at low water. It was considered that the excavation of a channel over the entire shoal would cost more than its importance with respect to the rest of the river would warrant, but that by the removal of the projecting reefs an increase of depth of a foot could be given at small cost. This latter project was approved early in October, and a force of men was immediately put to work. The reefs were closely drilled and blasted over a space 80 feet wide and 250 feet long, but, no derrick boat having been available for that work up to the time the November rise came, none of the rocks were removed. Work of removing the rocks will begin as soon as the river gets low enough.

HEAD OF HENRYS ISLAND.

The channel at this place in crossing the river passes between two large rocks on one side and one on the other, the channel being not more than 60 feet wide between them, with a swift cross current. Situated as they are in the middle of the river these rocks, which reach up almost to the water surface at low stages, rendered the crossing a very dangerous one at night or when the wind prevented determining their exact location. The rocks were drilled and blasted and 6½ cubic yards removed, giving an increase in depth of 15 inches over them. Cost, $23.72.

BEARDS REEF.

The project for this shoal was to cut a new channel down the left bank instead of attempting to improve the old channel, which made two abrupt bends in getting over the shoal. As many of the reefs as were exposed at the time were drilled and blasted in the fall of 1895, preparatory to removal with the dredge. Dredging was begun in the latter part of July of the present fiscal year, and continued till October. The reefs were of the hardest limestone and pure flint, and though blasted up as thoroughly as possible the cracked pieces were wedged together tight and were hard to remove with the dredge, straining it in many cases to its fullest capacity. Rocks containing from 2 to 3 cubic yards were often removed, and one rock estimated to contain 5½ cubic yards, weight 24,750 pounds, was swung around out of the channel. Others containing as much as 4½ cubic yards were put on barges and dumped in deep water. The ledges were inclined upstream at an angle to the river bed of about 45 degrees. The heaviest ledges, 4½ feet thick, were frequently cracked sufficiently to be removed without drilling by simply exploding dynamite under them in the pockets dredged from above. Above the reefs for a distance of 40 feet the river bed was of shale, and below, sand and gravel.

Rock and gravel dredged, 9,385 cubic yards, at a cost of 20.9 cents per unit.

A steam-derrick boat was used to clean up the ledges and bowlders the dredge would not handle, and accomplished the following work:

Rock removed with derrick, 190 cubic yards, at $1.44 per unit. Most of the rocks required to be blasted.

A channel 120 feet wide and 550 feet long was completed and thoroughly sounded to show a depth of 3 feet at low water. The method used for sounding was to attach a railroad rail to the ratchet chains and drop it over the bow of the steamboat to the required depth. Graduated iron rods were attached vertically to the rail to indicate when it was at the proper depth.

FLINT RIVER BAR.

By the time the dredge reached Flint River Bar the machinery was badly in need of repairs, and the work there was characterized by the number of breakdowns. The project was to dredge through the short bar along the right bank just below the mouth of Flint River. The old channel crossed from the mouth of Flint River to the left bank and back again in a distance of a quarter of a mile. The material dredged consisted of sand, gravel, bowlders, and ledges. The channel was left 3 feet deep at low water for a width of 60 feet and 2 feet deep for an additional 60 feet of width. To complete the 3-foot channel for the 120-foot width will require drilling, blasting, and removal of reefs over a space 30 feet by 60 feet.

* * * * * * *

Respectfully submitted.

W. S. Winn,
Assistant Engineer.

Capt. Dan C. Kingman,
Corps of Engineers, U. S. A.

Exhibit No. 11a.

REPORT OF MR. J. W. WALKER, ASSISTANT ENGINEER.

Florence, Ala., *October 11, 1894.*

Captain: I have the honor to submit herewith my report on a survey from Guntersville to Hobbs Island, Tennessee River, made pursuant to orders of Capt. Geo. W. Goethals, Corps of Engineers, U. S. A., dated September 5, 1894, with a view of obtaining a channel 4 feet deep at low water, and an estimate of same.

The field work was commenced September 13 and completed October 4, 1894. Localities surveyed: Beards Reef, Coles Bend, Paint Rock Bar, and Flint River Bar.

The general purpose of the field work was as follows: To locate all obstructions and ascertain the character of the bottom to 4 feet below low water by taking borings and soundings, to determine the level of water at time of survey, and as close as possible the low-water surface. Low-water mark was determined at each locality surveyed and gauges established and read twice each day during the survey.

At Beards Reef gauges were established above and below the reef and left for future reference, which were read simultaneously with the gauge at Guntersville. Inquiry was made from the oldest inhabitants in the vicinity concerning the lowest low water. Every precaution was taken to secure the above-mentioned data accurately.

A base line was located on the south bank at each place surveyed, measurements being made with steel tape. Each sounding was located carefully with two transits, occupying different points on the base line at a distance that would insure angles not less than 40 degrees; soundings made from a skiff handled by two boatmen. The skiff carried the rodsman, the assistant engineer as recorder, and an alternate boatman, who drove the steel rod to rock or to such depth below the surface as would insure proper grade without blasting; each location being given by the angles, which are in degrees and minutes from a back sight, carefully taken at each position of the transit. The recorder signaled with a small flag at each sounding located, giving four signals in white and the fifth in red to avoid errors.

The elevation of the bottom was taken not only by reading the depth of water on the rod, but also by actual reading of the rod with a level.

The triangulation and detailed soundings only extended above or below the obstruction farther than such points at which there are 4 feet at extreme low water. Borings were made with a pointed steel rod driven by a sledge. Occasional soundings were taken along the channel in the pools between the obstructions.

Leveling was done by one party working on the south side of the river, taking water-surface elevations every 1,200 or 1,400 feet, and at such other points as was necessary. A line of check levels was run over the entire distance, checking to +0.074 foot. Distance between Guntersville and Hobbs Island determined by chaining along the bank about 5 feet above low water, 20.71 miles, having a fall of 5.16 feet. Bench marks were located every quarter of a mile and fitly referenced.

While making the survey the party was quartered on a small barge belonging to the Nashville, Chattanooga and St. Louis Railway Company. The tents were erected on this barge, and as the survey advanced the barge was floated down the river. Arrangements were made with the Nashville, Chattanooga and St. Louis Railway Company to bring our mail and provisions from Guntersville.

The maps of Beards Reef and Paint Rock are being drawn on a scale of 50 feet to 1 inch, while Coles Bend and Flint River Bar are on a scale of 100 feet to 1 inch. The maps show all the soundings taken, figures in red, number of soundings, those in blue, elevation of bottom; letters "G" and "R" are used to indicate gravel and rock, respectively, gravel being bottom of river and rock determined by driving steel rod.

The detailed estimate of the cost of the improvement to secure a depth of 4 feet is given as follows, the plan of improvement proposed being the same as that now in progress on the river above this section, which has proved very satisfactory:

At Beards Reef, by reducing the waterway in width to 300 feet or 400 feet by the construction of a cross dam from the left bank along the crest of the reef, and having a crest about 2 feet above low water, terminating in a quadrant of 50 feet radius; the rock and bowlders in proposed channel to be blasted and removed and gravel excavation made at the upper approach. It may be necessary at some future time to build a check dam below, from one side or the other of the narrowed channel, but no provision is made for it in this estimate.

The order of construction recommended is to open a quarry, make the rock excavation, then construct the cross dam, and excavate the gravel simultaneously. A suitable quarry can be found about one-half mile below on left bank of river. Beards Reef is located 2 miles below Guntersville Landing.

Estimate of cost.

Dam, 2,135 cubic yards, at $3	$6,405
Excavation of rock, 300 cubic yards, at $5	1,500
Excavation of gravel, 4,000 cubic yards, at 25 cents	1,000
Total cost	8,905

In this estimate the width of dam on top is taken at 6 feet, slope 1 on 1, with gravel excavated with dredge and deposited as backing to dam. Rock excavated to be used in dam.

These calculations are based on the supposition that the work when once started will be prosecuted without interruption of any kind until completed. My prices may be a little high, but I wish to cover the cost.

Estimates of Coles Bend, Paint Rock, and Flint River bars will be submitted as soon as drawings can be completed.

Very respectfully, your obedient servant,

J. W. WALKER,
Assistant Engineer.

Capt. JOHN BIDDLE,
Corps of Engineers, U. S. A.

EXHIBIT No. 11b.

REPORT OF MR. J. W. WALKER, ASSISTANT ENGINEER.

Florence, Ala., October 20, 1894.

CAPTAIN: I have the honor to submit herewith my report on the survey of Flint River Bar and Paint Rock Bar, Tennessee River.

Flint River bar is located 18 miles below Guntersville landing. The river at this point is divided into two portions by a towhead located opposite and a little above the mouth of Flint River, the right-hand chute being the present steamboat channel. The obstruction consists of gravel overlaying a ledge of rock both above and below the towhead. At extreme low water the available depth is about 2 feet, and the fall about 0.86 foot.

From present indications the left chute should be opened to navigation by removing snags, cutting overhanging trees, breaking off the sharp projecting ledge on left bank, and excavating the gravel bar at upper end. In the meantime the action of the gravel can be watched, and it may be necessary to force more water into this chute by a check dam from the upper end of towhead. This chute has the least obstruction, and I am told by old steamboat men that it was used as a low-water chute until the deposit of snags and gravel cut them off.

Estimate of cost.

Excavation of gravel, 7,300 cubic yards, at 25 cents	$1,825.00
Excavation of ledge, 300 cubic yards, at $1	300.00
Removing snags	350.00
Cutting trees	200.00
	2,675.00
Contingencies, 10 per cent	267.50
Total	2,942.50

Paint Rock Bar is located 11.5 miles below Guntersville Landing and about 2.5 miles above the mouth of a tributary having the same name. At this bar the river had an average width of about 1,200 feet, during time of survey, and a fall of 0.36 foot.

The present channel is on the right side and the most favorable for improvement. The obstruction consists of a gravel bar, having three distinct ridges nearly perpendicular to the current, where dredging will be necessary to secure the 4-foot depth; and then to maintain this depth it is deemed best to build two check dams about 500 feet long, one taking root at station 8+50, extending through sounding No. 114; and the other at station 26, extending through sounding No. 316. It may be necessary to lengthen these dams after observing the result.

The gravel excavated can be used as backing to dams, and stone for constructing dams can be quarried from a bluff about 1 mile below the bar.

Estimate of cost.

Dam, 2,014 cubic yards, at $3	$6,042.00
Excavation of gravel, 9,000 cubic yards, at 25 cents	2,250.00
	8,292.00
Contingencies	829.20
Total	9,121.20

Tracings of Flint River Bar and of Paint Rock Bar are forwarded to you this date in a separate package.

All of which is respectfully submitted.

Very respectfully, your obedient servant,

J. W. WALKER,
Assistant Engineer.

Capt. JOHN BIDDLE,
Corps of Engineers, U. S. A.

EXHIBIT No. 11c.

REPORT OF MR. J. W. WALKER, ASSISTANT ENGINEER.

FLORENCE, ALA., *October 24, 1894.*

CAPTAIN: I have the honor to submit herewith the following report on survey of Coles Bend, Tennessee River. The survey was made from September 21 to September 23:

Coles Bend is the local name for a section of river beginning 8.5 miles below Guntersville Landing, with a length of 1.3 miles, width 1,200 feet, and low-water fall 0.79 foot.

The present channel is on the right side of the river. The soundings show rock along the left side and near center of river; therefore the right side seems most favorable for improvement.

The obstruction at this locality consists of two gravel bars, having an available depth at low water of about 2.8 feet. The channel here can be deepened to 4 feet by dredging, but to keep the required depth without further dredging I think it will be necessary to carry more water over to the right side with dams; one dam to take root at station 45, extending in the direction of sounding No. 247, and the other at station 79, extending in the direction of sounding No. 494, each dam to be about 500 feet long. The gravel can be used in backing dams. Stone for constructing dams can be quarried from a rock bluff about 1 mile above this place. The conditions at Coles Bend are very similar to those at Paint Rock Bar, neither of which is as great an obstruction to navigation as Beards Reef or Flint River Bar.

Estimate of cost.

Dams, 2,600 cubic yards, at $3	$7,800.00
Excavation of gravel, 8,270 cubic yards, at 25 cents	2,067.50
	9,867.50
Contingencies, 10 per cent	986.75
Total	10,854.25

A map of the survey is forwarded to you in a separate package this date.

Very respectfully, your obedient servant,

J. W. WALKER,
Assistant Engineer.

Capt. JOHN BIDDLE,
Corps of Engineers, U. S. A.

EXHIBIT No. 12.

Work done by U. S. steamer McPherson during the past season (1900) between Chattanooga and Decatur.

Nature of work.	Location.	Quantity.	Channel now available.		Remarks.
			Low-water depth.	Width.	
		Cu. yds.	*Feet.*	*Feet.*	
Rock excavated	Widows Bar	900	1.9	100	
Do	Island Bar	89	1.9	50	Reef in right slough below new elevator.
Do	Bridgeport Bar	15	1.9	....	Loose rock about one-half mile above bridge.
Do	Limestone Bar	355	2.5	150	
Do	Bracks Branch	55	2.5	30	End of reef taken out from middle of river.
Do	Burdine Bar	24	....	....	This bar is full of large bowlders, and when moved a 3-foot channel can be had.
Do	Bellefonte Crossing	40	1.8	200	
Do	Bellefonte Island	6	1.8	150	At lower point of island.
Do	Henrys Island	45	3.0	150	Reef blasted and taken out at head of island.
Snags pulled ......number	....	134	....	....	
Trees cut ......do	....	930	....	....	
Saplings cut ......do	....	543	....	....	

APPENDIX DD.

IMPROVEMENT OF OHIO RIVER BY OPEN-CHANNEL WORK AND CONSTRUCTION OF LOCK AND DAM NO. 37; OPERATING SNAG BOAT ON OHIO RIVER.

REPORT OF COL. G. J. LYDECKER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1902, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Ohio River.
2. Construction of Lock and Dam No. 37, Ohio River.
3. Operating snag boats on Ohio River.

SURVEY.

4. Ohio River from Marietta to mouth of the Big Miami.

United States Engineer Office,
Cincinnati, Ohio, July 23, 1902.

General: I have the honor to transmit herewith the annual reports of the works under my charge for the fiscal year ending June 30, 1902.

Very respectfully, your obedient servant,

G. J. Lydecker,
Colonel, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

D D I.

IMPROVEMENT OF OHIO RIVER.

GENERAL IMPROVEMENT.

As now carried on the work includes as its principal features (*a*) the direct improvement of bars and shoals by dredging and rock excavation; (*b*) construction, maintenance, and repairs of low dikes and dams; (*c*) construction, maintenance, and repairs of ice piers and harbors; (*d*) bank protection and the construction or repairs of embankments and levees where required in the interests of navigation; (*e*) surveys needed in connection with work in progress or for projecting new work and establishing harbor lines, and (*f*) miscellaneous, including care and record of certain water gauges, regulating encroachments by deposits on river banks in violation of law, supervising special permit work, etc.

Operations during the last fiscal year under the several items of work above indicated were as follows:

(*a*) DREDGING AND ROCK EXCAVATION.

General dredging operations were in progress from July 25 to December 14, 1901, this being the only period of the fiscal year during which the stage of water was suitable for such work. The total amount of material excavated was 112,424 cubic yards, scow measurement, at an average cost of 21.3 cents per cubic yard, as follows:

At Evansville, Ind., 7,364 cubic yards of mud, sand, and gravel for improving the landing at that place and the channel of approach thereto.

At Tradewater Bar, 6,152 cubic yards of sand for improving the low-water channel of the river.

At Weston Bar, foot of Tradewater Ripple, 37,404 cubic yards of mud, sand, gravel, rocks, and logs for improving low-water channel.

At Golconda, Ill., 13,313 cubic yards of loose rock, gravel, mud, and logs for improving the local landing and its channel of approach.

At Mound City, Ill., 26,022 cubic yards of sand and 22,169 cubic yards of cemented gravel that could not be dredged until broken up by explosives; the object of the work is to provide a new low-water channel as a substitute for the crooked and rock-obstructed one heretofore in use.

In connection with the above operations the dredges removed 52 snags, several rocks, and one wreck. The above-named places are all in the lower section of the river, at distances ranging from 783 to 959 miles below its head at Pittsburg, Pa.

The plant employed on the work consisted of the United States dredges *Ohio* and *Oswego* and four dump scows, with the towboat *Catherine Davis* serving under contract as tender to the fleet.

The United States dredges and scows went into winter quarters at Paducah, Ky., at the close of the working season, in December, 1901, where they remained until June 23, 1902, when the fleet left for Cincinnati in tow of the chartered steamer *Catherine Davis*, and arrived there July 3. Operations will be resumed as soon as the river falls to a suitable stage.

Rock excavation.—Bar at mouth of Licking River, where work was in progress from October 7 to November 10, 1901. Operations included dredging loose rock and gravel overlying the solid rock ledge, and drilling and blasting the latter before dredging. The total amount of material dredged was 10,184 cubic yards, scow measurement, at an average unit cost of $1.07 per yard, including towing and unloading; this part of the work was done by private plant, furnished and operated under contract, comprising 1 dredge, 1 towboat, and 8 flatboats. The preliminary work of breaking the rock ledge was done by hired labor engaged in operating the steam-drill boat belonging to the Government; in this way 1,259 holes, aggregating 5,020 feet in length, were drilled, and 3,375 pounds of dynamite used for blasting 2,572 cubic yards of rock, bank measurement, at a unit cost of $1.88 per cubic yard. Estimating the bank measurement as equivalent to 3,500 cubic yards of broken rock, scow measurement, the total unit cost of drilling, blasting, and dredging the solid rock was $3.35 per cubic yard of rock in ledge.

(*b*) LOW DIKES AND DAMS.

The construction of a new dike near the mouth of Tradewater River, below Caseyville, Ky., had been in progress during the year ending June 30, 1901, from August 24 to November 27, 1900, under contract with Hampton G. Grainger, of Caseyville, Ky., approved August 7, 1900, as described in Report of Chief of Engineers for 1901, pages 2625–2627. Work under the contract was resumed July 24, 1901, and continued until October 7, 1902, when the dike was nearly completed; the material placed in the work during this period was 1,200 feet B. M. of lumber and 5,597½ cubic yards of stone. At the close of the fiscal year the dike was 1,400 feet long, built to its full height of 6 feet above low water, except in a gap 200 feet long, which was temporarily left at a height of 4 feet below low water, but which will probably be filled to the same height as the rest of the dike during the present working season.

At Mound City, Ill., a contract with James Short, of St. Charles, Mo., approved August 13, 1900, provided for building one new dike and repairing an old one; the only work thus far done under the contract was the delivery of about 1,000 cubic yards of stone during the month of October, 1900, as described in Report of the Chief of Engineers for 1901, page 2606. No work was in progress during the last fiscal year, because the river was not at a low enough stage to permit any stone to be put in place under the limitations prescribed by the specifications. The contractor has recently requested permission to do so at a higher stage, and, as there is no good reason why such permission should not be given, his request will be granted; with this modification it is anticipated that considerable progress may be made during the present working season.

Maintenance and repairs.—Some minor repairs were made to several of the low dikes and dams, but the only considerable work of this character was at Blennerhassett Island, where repairs amounting to a practical reconstruction of the Back-channel dam were commenced under a special project providing for an expenditure of about $12,000, as approved by the Chief of Engineers August 28, 1901. The work was in progress from October 8 to November 17, 1901, when high water caused a suspension of operations, and prevented their resumption up to the close of the fiscal year. The projected work, and progress on it during the year, are summarized in the following extracts from report submitted December 31, 1901, by William M. Hall, assistant engineer in charge:

> The project as approved provides for making the repair as follows: To fill in those parts of the apron and slope which have washed out with a weakly made Portland cement concrete, finished on top with a strongly made concrete; to renew all the rotten and missing top ties with ties made by imbedding half-inch iron tie rods in a strong Portland cement concrete, and to patch all the broken places in the top paving with new paving, laid dry, the weakly made concrete to be composed mainly of large stone and gravel from alongside the dike, cemented with thinly made mortar, and

the strongly made concrete to be made of the same materials, but with much more mortar; in general, the old cross section to be retained, but with some slight decreases of area and some slight change of form at places where the old crib work has all been torn out; the work to be done by hired labor and by the purchase of supplies and materials in the usual manner, after due advertisement, but without contract; all possible delays to be avoided in order to complete work sufficiently before the arrival of new freshets, and all the work being therefore treated as emergency work.

* * * * * * *

At that time (September 7, 1901, on receiving orders to repair the dam) we had no tools, plant, or materials of any kind for doing the proposed work. I at once commenced preparing and issuing 10-day advertisements asking proposals for furnishing all the necessary materials, tools, etc., by purchase; and for the hire of boats, barges, a blacksmith, etc.

At the time of receiving the above order to repair the dam it was flooded. The water having receded to about a 5-foot stage, and tools, boats, and materials having been assembled, actual construction was commenced on October 8 with a small force, and gradually increased to about 70 men by the 14th. From October 14 to November 17 and from November 20 to 23 the work was vigorously prosecuted with from about 70 to 116 men. From November 17 to 19 the dam was flooded; and after November 24, on account of rain and flood, we were unable to do concrete work. The work was entirely suspended for the winter on November 28, and our force discharged.

The cost of operations to the date of suspension was $9,595.43. It is proposed to complete the repairs during the approaching low-water season.

In addition to actual work of repairs, a small field party was engaged in local surveys and examinations of dams and dikes between August 14 and November 23, 1901, under instructions to prepare estimates of cost of placing the entire system in substantial repairs, the work being a continuation of what had been begun in the fall of 1900. The examination included 70 dams and dikes at 31 localities scattered over a stretch of river 700 miles long, whose upper and lower limits are 185 and 967 miles below Pittsburg, Pa., and a large amount of office work has been devoted to mapping the local surveys and preparing detailed estimates of the cost of repairs. The information thus obtained will be utilized during the ensuing fiscal year in such work of this nature as is of most pressing importance.

(*c*) ICE PIERS.

No new piers were constructed, nor was any work in progress for repair or maintenance of old ones. But the two outer cribs of the pier at Portsmouth, Ohio, which had fallen to pieces and become obstructions to navigation, were removed. This work was commenced in June, 1901, by the United States snag boat, and was so continued until July 12, when the boat was needed for more important work; after that operations were carried on by hired labor, with many interruptions by high water, until November 20, when the outer crib (No. 4) had been removed to a level of about 3 feet and the adjoining crib (No. 3) to a level of about 5.5 feet above low water. Their entire removal was prevented by the high stage of water that has prevailed since last November, but it will probably be accomplished at some favorable opportunity during the approaching low-water season.

(*d*) BANK PROTECTION, ETC.

No work of this nature was in progress during the year, but the subject called for considerable time and attention, in field and office, for examinations and reports on complaints of erosion, and appeals for action by the Government for protection. The principal and most persistent complaints relate to erosions of the Ohio bank of the river between Mound City and Cairo, and of the Kentucky banks or shores in the vicinity of Paducah, Owensboro, and Ashland; several examinations and reports have been made respecting these special cases, and the recent river and harbor bill provides for special examinations or surveys as to some of them with reference to necessity of action by the Government "in the interests of navigation."

(*e*) SURVEYS.

The most important work of this nature during the fiscal year was the completion of the general survey of the river to the extent thus far authorized by Congress, viz, to the mouth of the Big Miami River; the field work was in progress from July 20 to September 23, inclusive, and resulted in completing the hydrographic and topographic work included in two sections of river aggregating 56 miles in length, one of which extended from 382 to 425 miles below Pittsburg, and the other from 441 to 454 miles below the same initial point. A full report of the survey was submitted January 14, 1902, and is printed as House Doc. No. 336, Fifty-seventh Congress, first session. It is desirable that it be also printed in the report of the Chief of Engineers for 1902. The maps of this survey have been drawn and traced on a scale of 200 feet to 1 inch, and it is of the highest importance that they should be on so large a scale for special purposes related to river improvements; but their reduction to a scale of 800 feet to the inch will be of much greater value for general purposes, and it is proposed to do this during the ensuing year.

(*f*) MISCELLANEOUS.

Harbor lines.—The principal work under this item during the fiscal year pertained to the establishment of lines at Steubenville and Ironton, Ohio, and for each place the subject was a matter of long and careful consideration, with public hearing or full conference with parties in interest, before definite conclusions were reached.

The Steubenville lines, as finally proposed by the district engineer officer, are shown on map submitted to the Chief of Engineers by Maj. W. H. Bixby, Corps of Engineers, with his report of January 13, 1902, and the general plan of these lines was approved by the Secretary of War, February 15, 1902, but before final adoption the district engineer was instructed to present the matter for consideration by interested parties at a public hearing, then mark the line as agreed upon on the ground by suitable monuments, and submit map of the line so marked, together with a full description of it, for final action by the Secretary of War. The hearing was duly held at Steubenville, Ohio, April 10, 1902, and report submitted to the Chief of Engineers May 8, 1902, but up to the close of the fiscal year the stage of water has continued too high to permit the required monuments to be established on the ground. These lines are about 8 miles long on each side of the river, and cover a distance of 2.3 miles above the Steubenville Bridge and 5.7 miles below it.

The Ironton lines recommended by the United States engineer officer are shown on map accompanying Major Bixby's report of January 14, 1902, and the general plan of these lines was approved by the Secretary of War, February 15, 1902; their final adoption awaits the erection of monuments defining the lines on the ground and the preparation of a map showing them, together with a detailed description of the line and its monuments, and this will be done as soon as the river stage becomes sufficiently low. These lines are 9.4 miles long on each side of the river, covering a distance of 6.3 miles above and 3.1 miles below Ironton, on the Ohio side, and a continuous distance of 9.4 miles from and below Ashland on the Kentucky side.

Permits from War Department.—Work in connection with special permits has been almost continuous during the fiscal year, and has absorbed a great deal of time, both in field and office, for necessary preliminary examinations and reports and subsequent supervision of the work authorized. The total number of such permits issued during the year, and pertaining to this district, was 46, of which 27 were for oil or gas pipe crossings, 10 for telephone or telegraph cable crossings, 2 for deposits on river banks within specified limits, and 7 miscellaneous.

Water gauge at Evansville, Ind.—This gauge was built by the United States in 1873, and consisted of a graduated iron strap about 290 feet long spiked to oak timbers sloping up the wharf or landing from low water to the top of river bank. Owing to rot and settlement the gauge had become very inaccurate, and its reconstruction necessary because all elevations related to improvements in that part of the river are referred to it. A contract was therefore made with Stinchfield & Saunders, of Evansville, Ind., under which 278 feet of the old gauge were removed and replaced by substantial rails of T iron imbedded in concrete, and the graduations plainly marked on both.

ESTIMATE.

The miscellaneous work incident to the general improvement of the Ohio River extends through a distance of nearly 1,000 miles; its essential feature is the formation, regulation, and maintenance of a low-water channel of such width and so located as to be reasonably safe and convenient for navigation, and with a uniform least depth through all bars and shoals. The result of work thus far done has been to provide such a channel at many places where low-water navigation was almost impossible, but the increased local depths thereby made are not fully available to commerce because there are many other places at which the depth is now very much less. It is plain that with a low-water depth of only 1 or 1½ feet over many of the bars and flats navigation must be correspondingly limited as to draft of boat, in spite of improvements that provide much greater draft at other places. It therefore follows that the conditions desired can only be obtained by appropriations sufficiently large to permit simultaneous and continuous work at all points where the improvements have not yet extended or developed the required uniformity of limiting navigable depth. This office does not contain the data necessary for estimating the probable cost of such a project; and a necessary preliminary to obtaining the data would be an extension of the general survey of the river to its mouth, a distance of 478 miles below the Big Miami, the point at which the recent survey authorized by Congress terminated. But there is information enough to show that an annual expenditure of not less than $500,000 would be required for three or four years to come in order to provide and maintain such desired low-water channel; and it is my opinion that the present and growing commerce of the river is ample justification for the expenditures at that rate. No such extensive work on the open-river channel will be required after the slack-water system to be provided by locks and dams has radically changed all the natural conditions, but it will probably be a matter of many years to bring that change about.

In order to make satisfactory progress on the improvement under consideration, a better and more extensive plant should be provided, increased dredging capacity being especially desirable, and also towboats for service in connection with dredging operations and suitable for other general work, including snagging, construction and repair of dikes and dams, surveys, inspections, and supervision.

For the purpose of carrying on operations pertaining to the several subdivisions of work indicated in this report, for continuing the general survey of the river to its mouth in order to obtain adequate data for future work, and for providing an efficient working plant, the above-stated sum of $500,000 will be required for expenditure during the fiscal year ending June 30, 1904, and a like amount for the next following year, in order to make such new improvements as are required to provide a reasonably uniform depth in the present shallows of the low-water channel, and, at the same time, do what is needed for perpetuating benefits already obtained.

Sub-reports of assistants in charge of the more important works are submitted herewith, and furnish more detailed information on the subjects to which they relate, viz: “Dredging,” report by E. J. Carpenter, asssistant engineer; “Bar at mouth of Licking River,” Tradewater dike,” and “Survey of Ohio River,” separate reports on each by R. R. Jones, chief assistant engineer.

Money statement.

July 1, 1901, balance unexpended		$237,220.85
Amount refunded July 29, 1901		3.34
Amount appropriated by river and harbor act, approved June 13, 1902. (Deducting $41,000 for falls at Louisville, Ky.)		359,000.00
		596,224.19
June 30, 1902, amount expended during fiscal year, $98,462.44, less $22.10 refunded Dec. 27, 1901		98,440.34
July 1, 1902, balance unexpended		497,783.85
July 1, 1902, outstanding liabilities		782.71
July 1, 1902, balance available		497,001.14
July 1, 1902, amount covered by uncompleted contracts		38,580.00
Amount (estimated) required for completion of existing project		Indefinite.
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902:		
For works of improvement	$600,000.00	
For maintenance of improvement	400,000.00	
		1,000,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Statement of amounts and dates of all appropriations for this work.

Act of Congress.	Appropriation.	Allotment.	Remarks.
March 3, 1827	$30,000.00		
March 3, 1835	50,000.00		
July 2, 1836	20,000.00		
March 3, 1837	60,000.00		
July 7, 1838	50,000.00		
June 11, 1844	100,000.00		
March 3, 1847	6,479.25		
August 30, 1852	90,000.00		
June 23, 1866		$172,000.00	Improving Mississippi, Missouri, Arkansas, and Ohio rivers.
Do		80,000.00	Snag boats and apparatus for improving Western rivers.
March 2, 1867	100,000.00		
July 25, 1868		85,000.00	Repair, preservation, extension, and completion of river and harbor works.
July 11, 1870	50,000.00		
March 3, 1871	50,000.00		
June 10, 1872	200,000.00		
March 3, 1873	200,000.00		
June 23, 1874	150,000.00		
March 3, 1875	300,000.00		
August 14, 1876	175,000.00		
June 18, 1878	300,000.00		
Do	50,000.00		Harbor of refuge at or near Cincinnati.
March 3, 1879	250,000.00		
June 14, 1880	250,000.00		
March 3, 1881	350,000.00		
March 21, 1882	100,000.00		Continuing work on Davis Island dam.
August 2, 1882	350,000.00		
Do	16,000.00		Harbor of refuge near Cincinnati, Ohio.
July 5, 1884	600,000.00		
Do	17,000.00		Do.
August 5, 1886	375,000.00		
August 11, 1888	380,000.00		
September 19, 1890	300,000.00		
January 19, 1891	2,128.87		Relief of Stubbs & Lackey. Treasury settlement No. 2593.
July 13, 1892	360,000.00		
August 18, 1894	250,000.00		
June 3, 1896	250,000.00		
July 1, 1898		15,000.00	For restoring levee and banks of Ohio River at or near Shawneetown, Ill.
March 3, 1899	375,000.00		
June 13, 1902	359,000.00		Amount appropriated, $400,000, $41,000 being for Falls of Ohio River, at Louisville, Ky.
Total	6,565,608.12	352,000.00	

Total of appropriations, 1827-1902	$6,565,608.12	
Total of allotments, 1827-1898	352,000.00	
Received from sales, 1866-1893	7,790.50	
		$6,925,398.62
Appropriations not drawn, 1827, 1852	5,023.47	
Allotments not drawn, 1866, 1868	43,134.60	
Returned by Treasury settlements	30.07	
Amounts transferred to other works	125,168.44	
		173,356.58
Total		6,752,042.04

LIST OF CONTRACTS IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1902.

Constructing dike below mouth of Tradewater River.—Hampton G. Grainger, July 27, 1900; approved August 7, 1900; be prepared to commence twenty days after receipt of notification of approval of contract; terminate on or before December 31, 1900, if stage of water permits; extended to December 31, 1901; completed October 7, 1901.

Constructing dikes in the Ohio River near Mound City, Ill.—James Short, July 30, 1900; approved August 13, 1900; be prepared to commence twenty days after receipt of notification of approval of contract; terminate November 30, 1900, if stage of water permits; extended to November 30, 1901; extended to November 30, 1902.

Hire of towboat and crew as tender to United States dredges.—The Smiley Towboat Company, June 20, 1901; approved July 5, 1901; commence when ordered; terminate about December 1, 1901; towboat discharged December 20, 1901.

Emergency contracts.

Dynamite, exploders, etc.—The Hercules Powder Company, September 24, 1901; commence when ordered; terminate December 15, 1901; completed December 15, 1901.

Hire of towboat.—W. J. Duffy, September 25, 1901; commence in ten days; terminate when discharged; towboat discharged December 18, 1901.

Hire of dredge.—William B. Bassett, September 25, 1901; commence in ten days; terminate when discharged; plant discharged December 14, 1901.

Hire of two flatboats.—T. J. Hall, September 25, 1901; commence in ten days; terminate when discharged; discharged December 16, 1901.

Hire of one flatboat.—John Barrett & Son, September 25, 1901; commence in ten days; terminate when discharged; discharged December 26, 1901.

Hire of one flatboat.—Galbreath & White, September 27, 1901; commence in ten days; terminate when discharged; discharged December 19, 1901.

Cement.—The Atlas Portland Cement Company, September 30, 1901; commence in ten days; terminate when entire quantity required is delivered; delivery completed November 30, 1901.

Hire of one flatboat.—R. H. Fleming, September 30, 1901; commence in ten days; terminate when discharged; discharged December 16, 1901.

Rebuilding water gauge at Evansville, Ind.—Stinchfield & Saunders, October 29, 1901; commence when ordered; terminate in thirty days; contract completed November 14, 1901.

Hire of towboat and one flatboat.—Robert Hornbrook, October 31, 1901; commence within five days after receipt of order; terminate when discharged; plant discharged December 6, 1901.

Hire of towboat and one flatboat.—Gordon C. Greene and Jesse P. Hughes, November 1, 1901; commence within five days after receipt of order; terminate when discharged; plant discharged December 14, 1901.

Hire of towboat.—The Smiley Towboat Company, November 2, 1901; commence within five days after receipt of order; terminate when discharged; steamboat *Mary Stewart* reported at Cincinnati, Ohio, but not being in accordance with the bid and specifications, she was not accepted.

Hire of steamboat.—Johnson Brothers' Towboat Company, November 12, 1901; commence within five days after receipt of order; terminate when discharged; discharged December 14, 1901.

Hire of three flatboats.—T. J. Hall, November 27, 1901; commence within five days after receipt of order; terminate when discharged; discharged December 16, 1901.

Hire of dredge.—Kanawha and Ohio Company, June 3, 1902; commence within ten days after receipt of order; terminate when discharged.

Hire of one flatboat.—S. N. Galbreath and Amos White, June 3, 1902; commence within ten days after receipt of order; terminate when discharged.

Hire of one flatboat.—S. N. Galbreath, June 3, 1902; commence within ten days after receipt of order; terminate when discharged.

Hire of two flatboats.—Oscar F. Barrett, June 3, 1902; commence within ten days after receipt of order; terminate when discharged.

Dynamite, exploders, etc.—Hercules Powder Company, June 4, 1902; commence when ordered; terminate December, 1902.

Hire of two flatboats.—T. J. Hall, June 7, 1902; commence within ten days after receipt of order; terminate when discharged.

Hire of towboat.—W. J. Duffy, June 9, 1902; commence within ten days after receipt of order; terminate when discharged.

STAGES OF THE OHIO RIVER DURING 1901.

The following are the records of the gauges at Pittsburg, Cincinnati, and Evansville, which may be taken to represent the navigable condition of the Upper, Middle, and Lower Ohio:

Gauge of Davis Island dam, near Pittsburg, Pa.

[When the dam is up, low-water readings must be obtained from the gauge at the lower end of the lock. On this gauge 3 feet 2 inches corresponds to a navigable depth of 3 feet, and 6 feet corresponds to the same depth in the river.]

Month.	Depth in channel.			Gauge readings.	
	Under 3 feet.	3 feet and over.	6 feet and over.	Highest.	Lowest.
1901.	*Days.*	*Days.*	*Days.*	*Feet.*	*Feet.*
January	0	31	16	13	4
February	0	28	2	7.2	3.6
March	0	31	27	18.8	3.8
April	0	30	30	25.8	3.6
May	0	31	26	16.6	5.4
June	0	30	30	12.7	6
July	8	23	0	5.8	2.4
August	17	14	2	6.3	2
September	0	30	5	7.4	3
October	23	8	0	3.5	2.3
November	14	16	8	11.5	1.8
December	0	31	30	24.3	5.9
Total	62	303	176	....	....

Cincinnati gauge.

[The zero of this gauge is about 2 feet below low water; readings of about 4 feet correspond to about 3 feet in the channel, and those of 7 feet to about 6 feet in the channel.]

Month.	Depth in channel.			Gauge readings.	
	Under 3 feet.	3 feet and over.	6 feet and over.	Highest.	Lowest.
1901.	*Days.*	*Days.*	*Days.*	*Feet.*	*Feet.*
January	0	31	31	28.8	9.6
February	0	28	28	20.9	8.3
March	0	31	31	36.4	7.6
April	0	30	30	59.7	23.9
May	0	31	31	51.2	16
June	0	30	30	40	17.7
July	0	31	31	23.8	7.4
August	0	31	27	12.8	5.8
September	0	30	30	14.7	7.4
October	0	31	18	8.9	4.8
November	0	30	9	11.4	4.2
December	0	31	31	39.5	10.7
Total	0	365	327	....	....

Evansville gauge.

[The zero of this gauge is about at low-water line; readings of 2 feet correspond to about 3 feet in the channel, and readings of 6 feet correspond to about 6 feet in the channel.]

Month.	Depth in channel.			Gauge readings.	
	Under 3 feet.	3 feet and over.	6 feet and over.	Highest.	Lowest.
1901.	*Days.*	*Days.*	*Days.*	*Feet.*	*Feet.*
January	0	31	31	20.6	8.7
February	0	28	28	15.5	7
March	0	31	27	27.7	5.7
April	0	30	30	41.8	20.9
May	0	31	31	41.8	11.4
June	0	30	30	28.6	14
July	0	31	31	25.8	6.7
August	0	31	18	9.6	3.4
September	0	30	30	10.6	6.3
October	3	28	3	7.5	2.6
November	26	4	0	4.3	1.7
December	0	31	28	28.8	4
Total	29	336	287	....	....

STAGES OF THE OHIO RIVER.

Highest, lowest, and average stages of the Ohio River at Cincinnati each calendar year from 1860 to 1901, inclusive, with the highest stage during the floods of 1832 and 1847.

Calendar year.	Highest stage.		Lowest stage.		Average for the year.
	Month.	Stage.	Month.	Stage.	
		Feet.		*Feet.*	*Feet.*
1832	February	64.2	.....	.....	.....
1847	December	63.6	.....	.....	.....
1860	April	49.2	October	5.3	16.0
1861	do	49.4	July	5.1	19.1
1862	January	57.3	October	2.3	17.4
1863	March	42.7	do	2.5	15.0
1864	December	45.1	August	3.1	16.7
1865	March	56.2	October	5.7	21.8
1866	September	42.5	August	4.7	19.2
1867	March	55.7	October	3.0	17.0
1868	do	48.2	July	5.1	18.7
1869	April	48.7	August	5.3	19.7
1870	January	55.2	October	3.8	17.8
1871	May	40.5	do	2.7	11.8
1872	April	41.7	do	3.0	11.7
1873	December	44.4	do	3.7	18.4
1874	January	47.9	September	2.3	15.7
1875	August	55.3	do	4.2	18.7
1876	January	51.7	do	6.2	18.2
1877	do	53.7	October	3.2	15.0
1878	December	41.3	do	4.3	16.7
1879	do	42.7	do	2.5	14.5
1880	February	53.1	do	3.7	17.0
1881	do	50.6	September	1.9	16.9
1882	do	58.6	November	6.1	[a]22.1
1883	do	66.3	September	3.6	[a]19.5
1884	do	71.0	do	2.7	[a]17.3
1885	January	46.0	do	2.5	[a]15.6
1886	April	55.7	November	3.3	[a]17.8
1887	February	56.2	September	2.7	[a]15.1
1888	April	39.9	August	5.2	[a]17.9
1889	February	38.2	September	5.2	[a]18.5
1890	March	59.2	August	5.7	[a]25.7
1891	February	57.3	October	4.4	[a]20.5
1892	April	43.7	November	3.4	[a]16.5
1893	February	54.9	August	3.6	[a]17.7
1894	do	35.6	September	3.1	[a]12.9
1895	January	48.4	October	2.3	[a]12.2
1896	April	47.8	September	5.5	[a]16.7
1897	February	61.2	October	3.1	[a]16.5
1898	March	61.4	do	4.5	[a]19.7
1899	do	57.4	November	3.4	17.1
1900	December	40.0	October	3.2	13.8
1901	April	59.7	November	4.2	17.6

[a] Prepared from the stages as shown by the waterworks marks daily at 6 a. m. and 6 p. m., the previous and succeeding years having been made from one daily observation at 6 a. m.

MONTHLY COMPARISONS OF RIVER AND RAINFALL.

Highest, lowest, and average monthly stages of the Ohio River and the monthly and annual rainfall at Cincinnati in two years ending December 31, 1900 and 1901.

Month.	Highest.				Lowest.				Average.		Rainfall.	
	1901.		1900.		1901.		1900.		1901.	1900.	1901.	1900.
	Date.	Feet.	Date.	Feet.	Date.	Feet.	Date.	Feet.	Feet.	Feet.	Inches.	Inches.
January	17	28.8	23–24	31.8	11	9.6	10–11	7.3	15.5	18.8	0.87	2.54
February	8	20.9	17	37.3	28	8.3	7	11.2	13.8	22.7	1.35	2.22
March	17	35.9	7	36.8	1	7.6	20	19.4	23.4	29.1	2.01	1.75
April	26	59.7	1	23	17	23.9	21	13.9	39.7	18	1.93	1.43
May	1	51.2	1	16	11	16.3	18–20	9.3	24.9	11.2	1.62	3.94
June	1	40	21	16.8	17	17.7	16–18	8.4	29.1	10.8	2.27	1.01
July	1	23.8	31	13.3	31	7.4	12	7.4	13.4	9.5	1.44	3.48
August	28	12.5	3	14.3	8	5.8	15–16	4.9	9.5	8	.88	4.17
September	23	14.6	1	7.7	30	8.5	19–20	3.5	10.8	4.9	.92	.28
October	5	8.9	29	11.4	30–31	4.8	20–22	3.2	6.5	4.2	.59	1.45
November	30	11.4	30	39	11	4.2	17–18	4.7	5.6	9.1	.74	4.50
December	20	39.5	1	40	7	10.7	26	7.8	14.2	19.2	3.37	1.01
For the year.	[a]26	59.7	[b]1	40	[c]11	4.2	[d]20–22	3.2	17.2	13.8	17.99	27.78

[a] April. [b] December. [c] November. [d] October.

Losses by collision with bridges.

The following table shows the reported losses sustained by the commerce of the Ohio River by collision with the piers of bridges crossing the Ohio River to the end of the calendar year 1901:

Date, etc.	Owner.	Steamboat.	Loss.	Amount.
Point Pleasant Bridge:				
Previously reported				$9,600.00
March, 1901	C. B. Crow and W. W. Hayman.	Valley Belle	Steamboat stacks.	50.00
Total				9,650.00
Kenova Bridge:				
Previously reported				24,900.00
March 17, 1901	The Monongahela River Consolidated Coal and Coke Co.	Tornado	2 coal boats	4,900.00
May 2, 1901	do	J. C. Risher	1 barge coal	2,250.00
May 30, 1901	do	Acorn	8 coal boats	16,800.00
December 30, 1901	do	Fred Wilson	6 coal boats, 2 flats.	15,600.00
Total				64,450.00
Ohio Falls Bridge:				
Previously reported				188,050.00
May 21, 1901	Pittsburg and Louisville Transfer Co.	City of Pittsburg	Damaged	2,000.00
Total				190,050.00
Henderson Bridge:				
Previously reported				22,520.00
April 22, 1901	The Monongahela River Consolidated Coal and Coke Co.	Coal City	6 barges coal	14,640.00
Total				37,160.00

NOTE.—The losses at the Kenova Bridge were reported by Mr. J. Frank Tilley, assistant secretary Pittsburg Coal Exchange; those at other bridges by the owners or masters of the vessels lost or damaged.

Losses by collision with Ohio River bridges to December 31, 1901.

Beaver Bridge	$61,840.00
East Liverpool Bridge	1,500.00
Steubenville Bridge	118,858.00
Wheeling and Martins Ferry Bridge	12,150.00
Bellaire Bridge	148,026.00
Parkersburg Bridge	101,848.47
Point Pleasant Bridge	9,650.00
Kenova Bridge	64,450.00
Newport and Cincinnati Bridge	48,107.00
Covington and Cincinnati Bridge	93,300.00
Cincinnati Southern Bridge	14,812.00
Louisville and Jeffersonville Bridge	7,800.00
Ohio Falls Bridge	190,050.00
Kentucky and Indiana Bridge	34,267.00
Henderson Bridge	37,160.00
Cairo Bridge	32,419.95
Total	976,238.42

General packet commerce of Ohio River in 1901.

[Compiled from reports made by owners, agents, and masters of vessels and transportation companies, in compliance with joint act of Congress approved February 21, 1891—Public No. 92.]

Name of boat or company.	Terminal points.	Distance.	In commission.	Freight.	Passengers.
		Miles.	*Months.*	*Tons.*	
Steamer S. P. Gillett	Pittsburg to Evansville	783	8	18,500	....
Pittsburg and Cincinnati Packet Line.	Pittsburg to Cincinnati	468	7	50,107	22,485
Steamer Cricket	Pittsburg to Gallipolis	269	12	1,832	1,479
Steamer Greenwood	.....do	269	9	13,122	11,745
Steamer Kanawha	.....do	269	8	12,800	11,240
Steamer Ben Hur	Pittsburg to Parkersburg	184	6.5	52,025	5,415
Steamer Eliza	.....do	184	2	4,000	2,000
Steamer Lorena	Pittsburg to Marietta	171	7	8,200	3,500
Monongahela and Ohio River Transportation Co.	Pittsburg to Wellsville	47	6	....	39,437
Steamer Florence Belle	Pittsburg to McKees Rocks	3	10	635	395,112
Toronto Ferry Co	Toronto to Zailla	1	8	....	32,179
Steamer Big Sandy	Steubenville to Wheeling	22.5	1	350	483
Steamer Nathaniel	Steubenville to opposite shore	1	11	....	16,988
Steamer T. M. Bayne	Steubenville to Wheeling	22.5	9	6,675	8,847
Steamer West End	Brilliant to Wellsburg	1	11	19,800	37,000
Steamer Lizzie Townsend	Martins Ferry to Bellaire	5	11	70,423	....
Steamer Buckeye	.....do	5	11	11,875	60,000
Steamer Conveyor	Martins Ferry to Wheeling	1.5	11	....	70,000
Steamer John C. Fisher	Wheeling to Louisville	508	10	81,040	....
New Haven Towboat Co	Wheeling to Cincinnati	378	10	70,600	....
Clarington and Wheeling Packet Co.	Wheeling to Parkersburg	94	8	10,600	27,354
Steamer H. K. Bedford	.....do	94	9	25,000	4,390
Steamer Nellie Bartlett	.....do	94	6	6,300	....
Steamer Ruth	Wheeling to Sistersville	47.5	8.5	5,075	20,000
Bellaire, Benwood and Wheeling Ferry Co.	Bellaire to Benwood	1	12	....	346,776
Steamer T. N. Barnsdall	Sistersville to Marietta	34	7	8,243	6,665
C. W. True	Sistersville to New Matamoras	4	12	....	40,500
Steamer Orion	Sistersville to Tuels Landing.	1	11	75	25,000
Steamer Valley Belle	Marietta to Gallipolis	98	9	11,200	5,652
Steamer Pioneer City	Marietta to Williamstown	1	12	48,180	62,450
Big Sandy Towboat Co	Parkersburg to Carrollton	357	12	12,200	....
Steamer Telephone	Parkersburg to Millwood	46.5	3	1,440	....
Steamer Nina Paden	Parkersburg to Belpre	1	11.5	9,000	100,000
Steamer Sandy Valley	Syracuse to Maysville	163	12	410,000	....
Steamer Klondike	Syracuse to Gallipolis	24	....	7,800	8,000
Steamer Douglas Hall	Pomeroy to Louisville	349	7	255,600	....
Cincinnati, Portsmouth, Big Sandy and Pomeroy Packet Co.	Pomeroy to Cincinnati	220	12	104,082	39,881
Jessie Towboat Co	.....do	220	7	700	....
H. D. Bailey	Pomeroy to Mason	1	10	5,400	35,000
Huntington and St. Louis Towboat Co.	Point Pleasant to Cairo	701	8	114,750	....
A. Montgomery & Co	.....do	701	10	179,500	....
Kanawha and Ohio Co	Point Pleasant to Louisville	334	7	337,996	....
Collins & Hartweg Co	Point Pleasant to Carrollton.	276.5	6	99,799	....
Marmet Co	Point Pleasant to Cincinnati.	204	12	367,950	....
Steamer Neva	Point Pleasant to Gallipolis	4.5	11.5	7,200	11,978
Steamer Charlie Stone	Point Pleasant to Fairhaven	1	12	....	15,000
Steamer Carrie Brown	Gallipolis to Huntington	39	11	28,640	19,854
Steamer Enos Taylor	.....do	39	9	12,000	8,000
Steamer Champion	Gallipolis to opposite shore	1	12	4,350	9,125
C. Crane & Co	Guyandotte to Louisville	294	12	400,000	....
Steamer Guayandotte	Guyandotte to Huntington	3	6	462	27
Steamer Arion	Guyandotte to Proctorville	1	11	16,500	24,750
G. W. Bay	Proctorville to Portsmouth	51	7	11,300	21,800
Steamer Urania	Huntington to Cincinnati	160	5	9,000	6,525
Steamer W. O. Hughart	Catlettsburg to Cincinnati	151	8	15,000	950
Steamer Wenona	Ashland to Coal Grove	1	....	....	127,750
Steamer Bob Ballard	Ashland to Ironton	5	12	463,620	....
Ashland Coal and Iron Railway Co.	Ashland to Portsmouth	33	12	57,130	....
Steamer Ironton	Ironton to Russell	1	12	12,922	96,386
Buena Vista Freestone Co	Buenavista to opposite shore.	1	9	4,000	....
Steamer W. H. Whiteman	Manchester to South Manchester.	1	12	18,030	48,414
Steamer P. K. Smiley	Ripley to South Ripley	1	12	7,200	16,408
Steamer Whisper	Augusta to Bonds Ferry	1	12	872	87,580
Steamer Mary F. Golden	Moscow to Addyston	41	6	12,730	36
Steamer New Richmond	New Richmond to South New Richmond.	1	12	4,160	18,000
Coney Island Co	Coney Island to Cincinnati, and excursions.	9	4.5	741	707,584

General packet commerce of Ohio River in 1901—Continued.

Name of boat or company.	Terminal points.	Distance.	In commission.	Freight.	Passengers.
		Miles.	*Months.*	*Tons.*	
Smith Coal and Sand Co	Dayton to Cincinnati	8	12	73,400	....
John Barrett & Son	Cincinnati to Cairo	497	9	63,000	....
New Orleans and Cincinnati Packet Co.	.....do	497	8	23,408	2,210
Pittsburg and Louisville Transportation Co.	.....do	497	8	15,000	4,000
Memphis and Cincinnati Packet Co.	.....do	497	9	18,854	2,719
Steamer City of Knoxville	Cincinnati to Paducah	452	5	690	87,420
Steamer E. T. Slider	Cincinnati to Stephensport	227	12	100,252	50
Louisville and Cincinnati Packet Co.	Cincinnati to Louisville	130	12	157,050	115,740
Steamer Levi J. Workum	Cincinnati to Carrollton	73	10	3,141	1,168
Steamer Boone No. 5	Constance to Riverside	1	12	10,950	11,100
R. H. Flemming	Ludlow to Addyston	12	12	12,004	....
Steamer Swan	Aurora to Risingsun	9	6	820	1,560
Louisville and Jeffersonville Ferry Co.	Carrollton to Leavenworth	117	12	....	1,033,291
Kentucky River Packet and Towboat Co.	Carrollton to Louisville	57	11	18,075	5,735
Kentucky and Indiana Ferry Co.	Madison to Milton	1	....	....	9,129
Steamer Alma	Louisville to Cairo	367	12	25,000	1,300
Bergenroth Brothers	do	367	10	41,000	....
J. H. Hoffman & Co.	Louisville Harbor	....	12	1,432,000	....
Louisville and Evansville Mail Co.	Louisville to Henderson	196	12	139,175	24,508
Steamer Rush	Louisville to New Albany	5	12	....	3,097
W. D. Crammond	Cannelton to Owensboro	82	12	4,600	82,784
Robert Hornbrook	Owensboro to Golconda	141	10	20,474	14,350
Steamer Wabash	Rockport to Cairo	225	12	16,728	5,965
Steamer Henderson	Newburg to Mount Vernon	50	....	1,400	5,000
Archbold Coal Co	Newburg to Evansville	14	10	92,000	....
Arnold Coal Co	Mouth Green River to Evansville.	8	12	72,000	....
Steamer Crescent City	.....do	8	9	15,120	6,720
Evansville and Bowling Green Packet Co.	.....do	8	12	6,300	4,500
Evansville, Ohio, and Green River Transportation Co.	.....do	8	12	48,005	....
Ingle and Hornbrook	.....do	8	10	9,000	....
Steamer I. N. Hook	.....do	8	12	20,468	....
Steamer Old Reliable	.....do	8	12	31,880	....
Steamer Peter Hontz	.....do	8	10	14,000	....
Evansville, Paducah, and Cairo Line.	Evansville to Cairo	182	12	37,250	44,450
Steamer John F. Buckham	.....do	182	10	305,389	2,551
Steamer Racket	.....do	182	12	....	12,000
Nashville and Evansville Packet Co.	Evansville to Paducah	137	....	17,800	4,000
Steamer Woolfolk	.....do	137	6	48,000	....
Steamer Alfred D. Owen	Evansville to Shawneetown	65	12	7,300	11,543
Steamer Georgia	.....do	65	12	350	1,875
Steamer Jewel	Evansville to Henderson	11.5	12	40,000	78,000
Illinois Central Railway Co	Evansville to McClain	4	11	214,265	28,216
Steamer Ruth	Henderson to Cairo	170	9	15,930	....
Steamer Penguin	Uniontown to Paducah	87.5	....	6,000	....
Ayer and Lord Tie Co	Shawneetown to Brooklyn	75	9	21,873	....
Paducah Coal and Mining Co	Caseyville to Paducah	59.5	12	2,887,500	....
Steamer City of Golconda	Golconda to Paducah	29.5	5	4,896	2,165
Steamer Waterloo	Golconda to Berry Ferry	1	12	1,000	10,000
Steamer Woodruff	Birdsville to Paducah	18	10	2,580	....
Steamer Cora Belle	Smithland to Cairo	57	12	142,000	....
Steamer Dick Clyde	Smithland to Joppa	28.5	9	12,000	....
Steamer Maggie Belle	Smithland to Paducah	12	7	17,375	....
St. Louis and Tennessee River Packet Co.	Paducah to Cairo	45	12	27,664	6,875
Steamer Wilford	Paducah to Joppa	16.5	12	4,612	....
Steamer Geo. H. Cowling	Paducah to Metropolis	9	....	3,750	33,944
Illinois Central Railway Co	Paducah to Brooklyn	3	12	235,919	19,000
Steamer Bettie Owen	.....do	3	12	2,000	18,000
Total	....	....	....	10,064,978	4,304,730

Statement of coal transported by the Monongahela River Consolidated Coal and Coke Company for the calendar year 1901.

Name of boat.	Between what points on the Ohio River.	Months in commission.	Tons towed.
Acorn	Pittsburg-Louisville	8	50,000
Adelle	do	3	35,000
B. D. Wood	do	6	62,000
Belle McGowan	do	6	45,000
Charlie Clarke	do	9	38,000
Cruiser	do	8	78,000
Clifton	do	9	54,000
Dick Fulton	do	6	80,000
Dave Wood	do	6	99,000
Ed Roberts	do	8	119,000
Enterprise	do	6	71,000
Exporter	do	6	53,000
Fallie	do	9	66,000
Fred Wilson	do	8	129,000
Hornet No. 2	do	7	88,000
Ironsides	do	8	61,000
I. N. Bunton No. 2	do	10	36,000
Josh Cook	do	8	99,000
Jim Wood	do	8	113,000
John Moren	do	9	107,000
Joseph Walton	do	8	64,000
J. C. Risher	do	7	72,000
John W. Ailes	do	9	80,000
Mariner	do	6	70,000
Nellie Walton	do	6	50,000
Pacific No. 2	do	8	104,000
Sam Brown	do	8	118,000
Sailor	do	6	40,000
Tornado	do	10	83,000
Tom Rees No. 2	do	8	106,000
Tom Dodsworth	do	7	112,000
Valiant	do	8	70,000
Volunteer	do	8	58,000
Bertha	Pittsburg-Bellaire	10	36,000
Charley Hook	do	10	70,000
Jim Brown	do	11	24,000
Maggie	do	11	85,000
Robert Jenkins	do	11	27,000
Robert McKinley	do		41,000
Stella Moren	do	11	63,000
Voyager	do	11	23,000
Alice Brown	Pittsburg-Cairo	8	163,000
Boaz	do	6	104,000
Coal City	do	8	149,000
Charles Brown	do	9	124,000
Defender	do	6	138,000
Iron Age	do	7	96,000
John A. Wood	do	9	159,000
J. B. Finley	do	9	228,000
Jos. B. Williams	do	9	227,000
James Moren	do	8	159,000
Harry Brown	do	8	131,000
Raymond Horner	do	8	203,000
Sam Clarke	do	8	118,000
W. W. O'Neil	do	8	111,000
Total			4,989,000

NOTE.—This statement represents the tonnage moved by each of the boats named, but not the volume of commerce, as the same commodity might be moved by four or five different steamers between Pittsburg and Cairo.

Respectfully submitted.

THE MONONGAHELA RIVER CONSOLIDATED COAL & COKE CO.,
HUGH MOREN,
Transportation Department.

PITTSBURG, PA., *April 29, 1902.*

Coal shipments from Pittsburg, Pa.

[Furnished by Mr. J. Frank Tilley.]

Month.	To Cincinnati.				To Louisville.			
	Trips.	Coal boats.	Coal barges.	Tons.	Trips.	Coal boats.	Coal barges.	Tons.
1901.								
January	7	9	64	43,110	28	230	238	347,020
March	17	176	180	264,400	59	523	233	622,670
April	9	40	108	96,320	29	155	347	334,630
May	13	25	190	126,350	32	191	247	324,830
June	5	1	71	39,290	6	27	84	71,010
August	2	....	13	7,020	....	....	....	....
September	3	....	42	22,680	....	....	....	....
November	17	58	202	164,180	14	85	144	158,510
December	13	99	73	137,470	21	328	139	386,660
Total	86	408	943	900,820	189	1,539	1,432	2,245,330

Total amount of coal shipped from Pittsburg to Cincinnati and Louisville, 3,146,150 tons.
NOTE.—No shipments from Pittsburg to Cincinnati or Louisville in February, July, or October.
Craft are based on coal boats of 950 tons and barges of 540 tons.

The movement of Pittsburg coal seems to be annually increasing to points in the far South, while near-by markets are barely holding their own or falling behind. Part of the coal consigned to Cincinnati, and so given in the table above, was afterwards taken to Louisville for shipment South.

Table showing coal shipments from Pittsburg during 1901.

	Tons.
Cincinnati	900,820
Louisville	2,245,330
Total	3,146,150

REPORT OF MR. R. R. JONES, CHIEF ASSISTANT ENGINEER, ON SURVEY OF OHIO RIVER, MARIETTA TO MOUTH OF BIG MIAMI RIVER.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, June 30, 1902.

COLONEL: I have the honor to submit herewith a report on survey of Ohio River, from Marietta to mouth of Big Miami River, for the fiscal year ending June 30, 1902.

The final report on this survey was submitted January 14, 1902, and was printed as House Doc. No. 336, Fifty-seventh Congress, first session.

The work done in previous seasons since the beginning of the survey is stated in annual reports for 1900, page 3092, and 1901, page 2608.

Operations during the fiscal year consisted of soundings and topography, resumed on July 20 by a party of 26 men, where suspended the previous season, continuing until September 23, when all field work was completed. The sections covered extended from 382 to 425 miles, and from 441 to 454 miles below Pittsburg, and were parts of the survey omitted in order to fully complete the section near Cullums Ripple for the report required on proposed dam at that locality.

The final field work was under the immediate supervision of Mr. C. B. Harris, who carried it out to a prompt and successful conclusion.

Since the submission of the report a small force has been employed in platting the large detail map of the survey. This work has now been completed, both the original drawings and the tracings from same, the drawings being platted to a scale of 200 feet to 1 inch.

A summary of the work performed during the seasons of 1899, 1900, and 1901, respectively, is given herewith:

Total soundings and topography, survey Marietta to Big Miami.

Date of survey.	Main channel.		Back channel.		Total.	
	Miles.	Soundings.	Miles.	Soundings.	Miles.	Soundings.
July 22 to Dec. 27, 1899	74.22	66,596	23.24	8,316	97.46	74,912
July 18 to Dec. 10, 1900	191.67	100,281	3.54	482	195.21	100,763
July 22 to Sept. 24, 1901	55.43	30,565	2.58	1,156	58.01	31,721
Total	321.32	197,442	29.86	9,954	350.68	207,396

Since the beginning of the survey on the upper portion of the Ohio (from Marietta to Pittsburg in 1896), there has been an increasing demand for copies of the map.

Owing to the relatively large scale to which the map has been platted, in order to permit of close study for location of the locks and dams, it is not convenient or economical to furnish copies for the use of outside parties. A reduced copy of map made, say, to a scale of about 800 feet to 1 inch, would enable this office to more readily fill the demands from outside parties interested in various business enterprises along the Ohio River. Such reduced copy by being lithographed might be supplied at small cost in the same manner as other printed documents of the Government.

Respectfully submitted.

R. R. JONES, *Chief Assistant Engineer.*

Col. G. J. LYDECKER,
Corps of Engineers.

REPORT OF MR. R. R. JONES, CHIEF ASSISTANT ENGINEER, ON REMOVING ROCK BAR AT MOUTH OF LICKING RIVER, KENTUCKY (468.4 MILES BELOW PITTSBURG; SURVEYS 1896–1900).

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, June 30, 1902.

COLONEL: I have the honor to submit the following report of operations in removing rock bar at mouth of Licking River for the fiscal year ending June 30, 1902:

This work has been fully described in past annual reports, and in particular the condition of bar and the methods employed for its removal are stated in Reports of the Chief of Engineers, Appendix D D, Part III, 1894, pages 1845–1848; Appendix C C, Part III, 1895, page 2339; Appendix C C, Part IV, 1896, pages 2079–2080.

The commerce of the Licking River is at present mostly restricted to the 3 or 4 miles immediately above its mouth, where its course lies past the cities of Covington and Newport, Ky. During low-water stages in the Ohio access to the Licking River has been prevented by the bar of loose and solid rock lying in the Ohio River and extending along the Kentucky shore above and below the mouth of the Licking.

The present project contemplates cutting a channel through this rock bar, with a depth of 4 feet at extreme low water and an average width of 200 feet.

During the entire progress of the work prior to 1901 material had been removed from the bar as follows:

	Cubic yards.
By cofferdam, fiscal years 1888 and 1892	3,619.6
By submarine blasting and dredging, fiscal years ending June 30, 1894–1896	26,245.1
Total	29,864.7

During the calendar year 1900 proposals for removing the rock and other material which compose the bar, at a fixed price per cubic yard, were twice advertised for.

The first set of proposals were opened July 19, the prices ranging from $1.94 to $15 per cubic yard. The lowest bidder having failed to enter into contract the work was readvertised.

The second set of proposals were opened October 31, when it was found that the prices ranged from $3.82 to $6.45 per cubic yard. Owing to the great discrepancy between the lowest bids received under the two separate advertisements, a recommendation was made by this office that the work be carried on by the methods employed during the fiscal years ending June 30, 1894, 1895, and 1896, viz, by the use of the Government drilling scow with hired labor, and by a dredging plant hired or purchased for the work. This was approved by the Chief of Engineers. The drilling plant owned by the United States was repaired, and a dredge, towboat, and flatboats were hired under 10-day proposals. Explosives and other supplies were purchased in the same manner, while the necessary labor required in operating the drilling scow and in unloading the dredged material was employed directly by the United States.

Repairs to the drilling scow, which had lain idle for about six years, were completed so that operations were begun early in October, 1901.

The work was continued during October, November, and for a part of December, until stopped by high water. The season's work, although short, was quite satisfactory as regards cost.

The total quantity of solid rock blasted during the fiscal year ending June 30, 1902, was 2,572 cubic yards, measured in place.

While the drilling scow was first engaged on the solid rock ledges, the dredge was employed to remove some rock blasted in 1895, which had been unavoidably left undredged at that time. A large amount of loose rock and gravel overlying the solid rock ledge was also dredged, and later the rock, freshly blasted, was removed. The material dredged was loaded on flatboats, towed down to Cullums Ripple, and unloaded at a point immediately below and behind the dike. The quantity thus removed and disposed of during the fiscal year ending June 30, 1902, was 10,184 cubic yards, barge measurement.

The cost of the work, exclusive of inspection, office expenses, etc., was $3.35 per cubic yard. A comparison, then, of the proposed contract price and the cost by the method pursued shows as follows:

Lowest proposal under opening of October 31, 1900	$3.82
Cost during season of 1901	3.35

It may be noted in passing that the cost of the work by open cut in cofferdam, in years 1888 and 1892, ranged from $12.50 to $13 per cubic yard.

In determining the cost of the work, the extraordinary repairs to drilling scow were added by dividing the total cost of such repairs by the total quantity of solid rock to be removed. The proportionate amount per cubic yard thus obtained was added to the other items of cost for explosives, supplies, and hired labor.

The following statement shows the amount of solid rock blasted by the use of steam drills and submarine charges since this method was first adopted:

Fiscal year ending June 30—	Cubic yards.
1894	892.20
1895	2,082.68
1896	2,736.00
1902	2,572.00
Total	8,282.88

The total material (solid rock, loose rock, gravel, and sand) removed since the work was first undertaken has been as follows:

	Cubic yards.
By open cut in cofferdam, fiscal years ending June 30, 1888 and 1892	3,619.6
By blasting solid rock and by dredging the rock, gravel, and sand, fiscal years ending June 30, 1894, 1895, 1896	26,245.1
By blasting solid rock and by dredging the rock, gravel, and sand, fiscal year ending June 30, 1902	10,184.0
Total	40,048.7

Summary of holes drilled, etc.

Fiscal year ending June 30—	Number of holes drilled and blasted.	Total depth.
		Feet.
1894	832	2,441.6
1895	1,194	4,859.9
1896	1,958	7,212.3
1902	1,259	5,020.0
Total	5,243	19,533.8

Various items of cost for fiscal year ending June 30, 1902.

	Quantity.	Value.
Dynamite		
No. 1 ... pounds	875	$431.25
No. 2 ... do	2,500	
ExplodFers, insulated ... number	1,400	276.86
Muslin for wrappers ... yards	189	11.31
Twine for making up cartridges ... pounds	20	3.40
Rubber tubing for insulating joints ... feet	250	9.00
Connecting and leading wire ... do	1,300	7.60
Total explosives, etc		739.45

Various items of cost for fiscal year ending June 30, 1902—Continued.

	Quantity.	Value.
Fuel		$85.44
Repairs		1,190.06
Supplies, including rope, oils, lumber, etc		556.23
Miscellaneous expense, including printing and advertising, travel expense, telegrams, towing, etc		515.96
Labor and inspection		1,753.34
Total		4,840.48
Cost per cubic yard rock drilled and blasted		1.88

Cost of dredging, including towing and unloading.

Dredge, hired under proposals	$2,905.93
Flatboats, hired under proposals	2,284.00
Towboat, hired under proposals	1,838.71
Labor, unloading dredged material	1,254.35
Inspection and miscellaneous expenses	2,654.17
Total	10,937.16
Cost per cubic yard dredging, etc	1.07

During the latter part of the present fiscal year the capacity of the Government drilling plant has been increased by the addition of a third steam drill, larger and more powerful than the two hitherto in use.

It is now proposed to resume operations about July 1, 1902, with the steam drilling plant, together with dredge, towboat, and flatboats hired for this work. The present indications point to a long and successful season's work.

During the season of 1901 the work was carried on under the immediate supervision of Mr. C. B. Harris, inspector, who has shown marked fidelity to his duties.

Respectfully submitted.

R. R. Jones,
Chief Assistant Engineer.

Col. G. J. Lydecker, *Corps of Engineers.*

REPORT OF MR. R. R. JONES, CHIEF ASSISTANT ENGINEER, ON DIKE NEAR MOUTH OF TRADEWATER RIVER.

United States Engineer Office,
Cincinnati, Ohio, June 30, 1902.

Colonel: I have the honor to submit herewith a report of operations in construction of a dike near the mouth of Tradewater River, below Caseyville, Ky., for the fiscal year ending June 30, 1902.

This work is described in Appendix G G, Report of Chief of Engineers, 1901, Part IV, pages 2625-2627.

Work on the dike was resumed July 24, 1901, and was carried on until October 7, 1901, when all the work then decided on had been completed except a small amount of protection work on the downstream side of the dike near the shore end.

The dike was carried up to its full height (6 feet above low water), except at the opening near the Illinois shore, which was purposely left for a width of 200 feet at an elevation 4 feet below low water.

Observations made during the season of 1901 lead me to believe that this opening should now be closed entirely, as an extensive scour is taking place immediately below it, and it is believed that the longer the closing of the gap be delayed the greater will be the cost of such filling.

The material placed in the dike during the fiscal year ending June 30, 1902, has been as follows:.

Lumber	feet B. M..	1,200
Stone, large class	cubic yards..	207
Stone, small class	do....	5,390.4

The total material placed in dike, fiscal years ending June 30, 1901 and 1902, has been—

Lumber	feet B. M.	12,426
Piles	number	246
Spikes, kegs of 150 pounds	do	2
Excavation, shore end	cubic yards	192.5
Stone, large class	do	207
Stone, small class	do	13,993

Total cost to close of fiscal year ending June 30, 1902, $15,409.28.

The work in season of 1901, as in 1900, was under the efficient supervision of Mr. G. Fred Allen.

The effect of the dike, as far as could be observed during the season of 1901, has been to straighten and improve the channel in its immediate vicinity. It is not unlikely, however, that further works in the near neighborhood will be required before the desired improvement can be obtained.

Respectfully submitted.

R. R. Jones,
Chief Assistant Engineer.

Col. G. J. Lydecker, *Corps of Engineers.*

REPORT OF MR. E. J. CARPENTER, ASSISTANT ENGINEER, ON RECONSTRUCTION OF OHIO RIVER WATER GAUGE AT EVANSVILLE, INDIANA.

United States Engineer Office,
Cincinnati, Ohio, March 24, 1902.

Colonel: I have the honor to report as follows on reconstruction of the Ohio River water gauge at Evansville, Ind., referred to me by Major Bixby's letter of July 10, 1901.

The Evansville gauge, located on the public wharf at the foot of Main street, was built under the direction of Col. William E. Merrill, Corps of Engineers, U. S. Army, in 1873. It consisted of a graduated iron strap, one-half inch by 4 inches, spiked on top of 4-inch by 12-inch oak timbers, extending along the surface of the wharf from low-water mark to the top of the bank at Water street; the longitudinal timbers being flush with the wharf paving, and supported on oak trestles, buried in the ground, about 6 feet apart.

The graduated strap had for several years past frequently become loose for a considerable part of its length, and as it could no longer be held in place by spikes, an examination of the gauge was made and the oak timbers found to have rotted and settled down to an extent that impaired the accuracy of the graduations. As proper repair involved thorough reconstruction, new plans for a permanent gauge were prepared, and after ten days' advertisement a contract for the work was made with Messrs. Stinchfield & Saunders, of Evansville, who promptly carried it to completion, beginning on November 2 and finishing on November 14.

The old gauge was removed, with its foundation and the adjoining wharf paving, making a trench 2 feet 6 inches wide and 2 feet 3 inches deep for the entire length, the trench being then filled to a depth of 9 inches with compactly rammed gravel, to insure proper drainage.

The new gauge consists of T-rails weighing 20 pounds per foot, in 30-foot lengths, joined by the usual standard fish plates, making it continuous for the entire length of 278 feet.

The T-rails are laid inverted in a bed of concrete 18 inches deep and 24 inches wide, built in 10-foot lengths on the gravel foundation. The concrete was made of 1 part Portland cement, 2 parts of clean, coarse sand, and 4½ parts clean gravel, for a depth of 16 inches; the remaining 2 inches being finished up flush to the top surface of the rail with a dressing made of 1 part cement to 2 parts of sand, put on before the concrete had set.

Graduation marks, which were made to correspond with those of the original gauge, were cut in the exposed surface of the rail at each one-tenth foot, from eight-tenths foot of elevation to 46$\frac{3}{10}$ feet. Each foot was marked by figures 1 inch high cut in the rail, and by figures 4 inches high and three-eighths inch deep stamped in the top dressing, the large figures being afterward filled with cement tinted red and outlined with a slight depression, making all easily legible.

The gauge follows the general grade of the wharf, but below eight-tenths foot, where the T-rail terminates, it is finished to zero with a 4 by 12 inch oak timber 3 feet 6 inches long, bedded in concrete and faced with an iron plate one-half inch by 4 inches.

The contract price, $2.47 per linear foot, made the total cost $686.66; which included removal of the old structure, building the new one complete, and renewing the wharf paving on each side.

Respectfully submitted.

E. J. CARPENTER, *Assistant Engineer.*

Col. G. J. LYDECKER, *Corps of Engineers.*

REPORT OF MR. E. J. CARPENTER, ASSISTANT ENGINEER, ON WORK OF THE OHIO RIVER DREDGES DURING THE CALENDAR YEAR 1901.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, March 24, 1902.

COLONEL: I have the honor to submit the annual report of operations of United States dredges *Ohio* and *Oswego*, for the calendar year 1901, with tabular statements showing cost, amount of excavation, etc., at the various places where dredging was done.

* * * * * * *

As there was not sufficient money available for general work on the river, the plan for the season's dredging necessarily limited operations to the places having unexpended special allotments for such work, viz, Evansville, Ind.; Tradewater Bar, and Golconda, Brooklyn, and Mound City, Ill.; and as all these are on the lower river, where the stage of water was too high for work early in the season, the dredges were obliged to remain longer than usual in winter quarters at Paducah, Ky.

Leaving Paducah on July 7 the plant reached Evansville on the 10th, and was then put in working order, ready to begin operations as soon as the river fell to a suitable stage.

The most important work on hand was the completion of the Mound City improvement, and the plant was therefore employed at other places only while the river remained too high for operations there.

EVANSVILLE, IND., 783 MILES BELOW PITTSBURG.

Under the project approved April 10, 1899, for expenditure of $20,000 diverted by the river and harbor act of March 3, 1899, from the unexpended balance of the appropriation of June 3, 1896, for dredging along the city front of Evansville, Ind., the United States dredges were employed from July 25 to August 5 to widen the channel and to deepen the approach to the public wharf by cutting away the bar in front of it, continuing the work begun by hired dredge plant in 1900.

Two cuts were made, each 35 feet wide and 6 feet below low water; one extending 595 feet along the water line at the principal landing at the wharf, above the lower line of Vine street; and the other cut, 305 feet long, widening the channel near the wharf between Vine and Division streets. The excavated material was dumped on the Kentucky side of the channel below Dike No. 6.

Excavation made July 25 to August 5, 1901: Mud, sand, and gravel, 7,364 cubic yards.

TRADEWATER BAR, 862 MILES BELOW PITTSBURG.

While on the way down from Evansville to Mound City the dredges stopped at Tradewater to make a cut through the sand reef, from the Kentucky channel above the towhead to deep water on the Illinois side. One cut 1,225 feet long was made, the excavated material being thrown into bank on the downstream side, forming a temporary dike to increase the scour by confining the current to the cut.

With the Tradewater gauge reading 4.5 feet, the cut was made 9 feet deep for a distance of about 600 feet, after which it was found necessary to shoal up to 7 feet, because the sand reef, working down with the river current, built up ahead of the dredge to such extent that the amount of light sand to be excavated could not be made to stand in bank. The cut extended from 7 feet depth above the reef to 5 feet depth in the Illinois channel.

Excavation made August 8 to 11, 1901.

Sand	cubic yards	6,152
1 log removed	tons	2.2

WESTON BAR, FOOT OF TRADEWATER RIPPLE, 864.5 MILES BELOW PITTSBURG.

On completion of the cut above Tradewater towhead, the dredges proceeded to Mound City, as the river had fallen to the limit for safe travel and all reports indicated the probability of a continued fall; but after their arrival at Mound City and before work was begun reports were received of a flood in the Tennessee and Cumberland which would prevent work below those rivers for several weeks at least. The dredges therefore returned up the river as far as Weston, where they were employed to clear out and deepen the channel along the Kentucky shore made by the new Treadwater dike, then nearly completed.

This work consisted of dredging through the bar along the Kentucky shore below Camp Creek, where two cuts about 1,500 feet long were made to increase and direct the current through the new channel; clearing away a deposit of logs, clay, gravel, etc., washed out on the bar by the creek, and removing a point composed of stone bedded in hard clay, which projected into the channel from the Kentucky shore above the creek.

The first cut through the bar made a decided improvement, and as all hard material in line of the new channel was dredged out, the current from the new dike scoured away the sand, widening and deepening the channel during the rest of the season. The total length of the dredged area is 2,500 feet, the depth being 5 feet below low water and the width varying from 70 to 150 feet.

The excavated material was dumped on the Illinois shore opposite Weston, where it was utilized to form a low dike extending about 300 feet out from shore.

Excavation made, August 21 to September 21, 1901.

Sand	cubic yards	28,124
Mud, sand, and gravel	do	7,210
Loose rock	do	2,070
Logs and snags removed (31)	tons	42.4
Rocks removed (2)	do	2.3

GOLCONDA, ILL., 890 MILES BELOW PITTSBURG.

Under the project approved April 1, 1899, for expenditure of $10,000 for dredging the harbor at Golconda, Ill., appropriated by the river and harbor act of March 3, 1899, the United States dredges continued the work at Golconda begun by the hired dredges in 1897 and 1899.

During the higher stage of river the boats were engaged in widening the channel on the Illinois shore at the Golconda wharf; but as soon as the stage of water would permit they began improving the river channel and the approach to the landing by cutting away the point of the rocky bar on right of the channel just above the town.

At the wharf the area dredged, 6 feet below low water, was 1,250 feet long, 35 feet wide for a distance of 1,070 feet, and 70 feet wide for the remaining 180 feet. At the rock bar, where four adjoining cuts were made, 6.5 feet below low water, the dredged area has an extreme length of 600 feet, the width being 140 feet at the upper end and 105 feet at the foot.

The excavated material, which consisted of mud, gravel, and logs at the landing and densely packed stone at the rock bar, was dumped on the left of the channel, above the foot of Golconda Island.

Excavation made September 23 to October 10, 1901.

Gravel, mud, and logs	cubic yards	7,490
Loose rock	do	5,823
Logs and snags removed (20)	tons	21.4
Wreck removed		1

MOUND CITY, ILL., 959 MILES BELOW PITTSBURG.

Under the project approved April 3, 1899, for the expenditure of $25,000, appropriated by the river and harbor act of March 3, 1899, for dredging and diking at Mound City, Ill., dredging at this place was resumed on October 14, the earliest date at which the river became low enough for work without interruption from high water.

The work was a continuation of the dredging begun in 1898 and prosecuted each year since whenever the stage of river would permit, the object being to open a channel direct to the Illinois chute, at Mound City wharf, from midriver opposite the towhead, and thus to avoid the crooked and dangerous route of the old low-water channel among the rocks along the Kentucky shore.

For the past three seasons the dredging has been applied as far as possible to the removal of a bar of cemented gravel, about 1,200 feet long, in line of the new channel. This material, which in many places extends up to the low-water level, is too hard to dredge without first breaking it up with dynamite, and is usually covered with a layer of sand which must be scraped off with the dredge dippers before blasting.

Previous to 1901 a width of 170 feet had been cut through the hard bar, establishing the low-water channel on the desired new line. During 1901 three additional cuts were carried through, increasing the clear width to 260 feet, and a fourth cut, making the total width 290 feet, had been completed with the exception of 100 linear feet when high water and severely cold weather compelled a suspension of operations for the season. All excavation was made 6 feet below low water.

The excavated material was utilized, as far as possible, to close the abandoned Kentucky channel by making a bank of dumps across its upper entrance, above the line of the proposed new dike.

Excavation made October 14 to December 14, 1901.

Sand	cubic yards..	26,022
Cemented gravel	do....	22,169

A rapid general rise of the river, accompanied by stormy and extremely cold weather, stopped operations on December 14, and as there was no prospect of conditions suitable for further work, the dredges were moved to winter quarters at Paducah, Ky. After necessary preparations for care of the plant were made, the crews, with the exception of two enginemen left in charge for the winter, were furloughed without pay.

Respectfully submitted.

E. J. Carpenter, *Assistant Engineer.*

Col. G. J. Lydecker, *Corps of Engineers.*

OHIO RIVER DREDGING STATEMENT FOR 1901.

Dredges in commission.

TIME.

Time at work.	Days.	Time lost.	Days.
Dredging sand	27.8	Sundays	18
Dredging cemented gravel	23.9	Holidays	2
Dredging mud, sand, and gravel	7.2	Traveling	8.4
Dredging loose rock	5.2	High water	10.9
Dredging gravel, mud, and logs	4.4	Low water	1.5
Removing logs and snags	1	Fog	0.1
Removing rocks	0.1	Coaling	2
Removing wrecks	0.1	Accidents	33.4
Total	69.7	Total	76.3

Total in commission, 146 days.

WORK.

Nature of work.	Per day of work.	During the season.
	Cu. yds.	*Cu. yds.*
Sand excavated	2,169	60,298
Cemented gravel excavated	927.6	22,169
Mud, sand, and gravel excavated	2,024.2	14,574
Loose rock excavated	1,517.9	7,893
Gravel, mud, and logs excavated	1,702.3	7,490
Total excavation for the season	....	112,424
	Number.	Tons.
Logs and snags removed	52	66
Rocks removed	2	2.3
Wrecks removed	1	....

COST.

Equipment for the season	$1,069.10
Towing and fuel for the season	7,417.89
Repairs for the season	1,379.61
Salaries for the season	7,376.56
Dynamite for use at Mound City, Ill	671.21
Total for the season	17,914.37

Dredges out of commission.

TIME.

	Days.
In ordinary	183
Annual repairs	36
Total	219

COST.

Salaries in ordinary	$2,964.61	
Total in ordinary		$2,964.61
Salaries during annual repairs	$1,895.54	
Annual repairs (shop bills, materials, etc.)	1,162.54	
Total cost of repairs		3,058.08
Total out of commission		6,022.69
Cost per day in ordinary (including superintendent's pay)		16.20

Cost of work, including all expenditures, in 1901.

Dredging sand	$9,547.34
Dredging cemented gravel	8,207.96
Dredging mud, sand, and gravel	2,472.70
Dredging loose rock	1,785.85
Dredging gravel, mud, and logs	1,511.10
Removing logs and snags	343.43
Removing rocks	34.34
Removing wrecks	34.34
Total expenditure in 1901	23,937.06

Cost per unit.

Per cubic yard of excavation	$0.213

The day of work is for actual operation of two dredges with four dump scows and one towboat for tender, making good every hour lost by accident or otherwise.

The towboat *Catherine Davis*, chartered as dredge tender, was paid $47 per day, this amount covering the cost of the boat, with outfit, crew, and fuel for the towboat and dredges, except that all cost of coal in excess of 5 cents per bushel was repaid by the Government.

The "total expenditure," on which the cost of work is based, covers all outlay properly applicable to the season of 1901, including the cost of superintendence, office work, etc.

Location and description of work.

Place.	Miles from Pittsburg.	Date—1901.	Days of work.	Logs and snags.		Rocks.	
				No.	Tons.	No.	Tons.
Evansville, Ind	783	July 25–Aug. 5	3.8				
Tradewater Bar	862	Aug. 8–11	3.1				
Do	862	Aug. 9	.1	1	2.2		
Weston, Ky	864.5	Aug. 21–Sept. 19	11.2				
Do	864.5	Sept. 7–21	3.4				
Do	864.5	Aug. 23–28	1.1				
Do	864.5	Aug. 23–Sept. 21	.6	31	42.4		
Do	864.5	Aug. 28–Sept. 18	.1			2	2.3
Golconda, Ill	890	Sept. 23–Oct. 3	4.4				
Do	890	Sept. 24–Oct. 10	4.1				
Do	890	Sept. 24–28	.3	20	21.4		
Do	890	Oct. 4	.1				
Mound City, Ill	959	Oct. 14–Dec. 13	13.5				
Do	959	Oct. 14–Dec. 14	23.9				
Total			69.7	52	66	2	2.3

Place.	Wrecks.	Excavation.						
	No.	Sand.	Cemented gravel.	Mud, sand, and gravel.	Gravel, mud, and logs.	Loose rock.	Per day of work.	Cost per cu. yd.
		Cu. yds.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	
Evansville, Ind				7,364			1,937.6	$0.177
Tradewater Bar		6,152					1,984.5	.173
Weston, Ky		28,124					2,511.1	.137
Do				7,210			2,120.6	.162
Do						2,070	1,881.8	.182
Golconda, Ill					7,490		1,702.3	.202
Do						5,823	1,429.2	.242
Do	1							
Mound City, Ill		26,022					1,927.6	.178
Do			22,169				927.6	.370
Total	1	60,298	22,169	14,574	7,490	7,893		

Place.	Expenditures.								
	Removing logs and snags.	Removing rocks.	Removing wrecks.	Dredging sand.	Dredging cemented gravel.	Dredging mud, sand, and gravel.	Dredging gravel, mud, and logs.	Dredging loose rock.	Total for 1901.
Evansville, Ind						$1,305.03			$1,305.03
Tradewater Bar				$1,064.64					1,064.64
Do	$34.34								34.34
Weston, Ky				3,846.41					3,846.41
Do						1,167.67			1,167.67
Do								$377.78	377.78
Do	206.06								206.06
Do		$34.34							34.34
Golconda, Ill							$1,511.10		1,511.10
Do								1,408.07	1,408.07
Do	103.03								103.03
Do			$34.34						34.34
Mound City, Ill				4,636.29					4,636.29
Do					$8,207.96				8,207.96
Total	343.43	34.34	34.34	9,547.34	8,207.96	2,472.70	1,511.10	1,785.85	23,937.06

D D 2.

CONSTRUCTION OF LOCK AND DAM NO. 37, OHIO RIVER.

The river and harbor act approved June 13, 1902, contains the following item:

> Improving Ohio River: Continuing improvement by the construction of a lock and dam numbered thirty-seven at Home City, between Cullums Ripple and Medoc Bar, below Cincinnati, Ohio, in accordance with the report submitted in House Document Numbered Three hundred and thirty-six, Fifty-seventh Congress, first session, one hundred thousand dollars: *Provided*, That a contract or contracts may be entered into by the Secretary of War for such materials and work as may be necessary to complete the said lock and dam, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate nine hundred and fifty thousand dollars, exclusive of the amount herein appropriated.

Operations under this appropriation will be commenced as soon as the river falls to a favorable stage, and the funds now available will probably be applied to (1) surveys, borings, etc., required for final selection of site for the lock and dam, (2) purchase of necessary lands, (3) preparation of detailed plans and specifications adapted to the site, and (4) perhaps the work of actual construction may be commenced.

The amount of appropriation that will be required annually after construction is commenced can not be very closely indicated at present, but if the work should proceed at the desired rate of progress an appropriation of $500,000 should be available for expenditure during the fiscal year ending June 30, 1904.

Money statement.

Amount appropriated by river and harbor act approved June 13, 1902	$100,000.00
July 1, 1902, balance unexpended	100,000.00
Amount (estimated) required for completion of existing project	950,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1904, in addition to the balance unexpended July 1, 1902	500,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

DD 3.

OPERATING SNAG BOATS ON OHIO RIVER.

The act of Congress of September 19, 1890, as modified by that of June 3, 1896, provided for yearly appropriations of $50,000 for this work. For phraseology of these acts and further details see the Annual Report for 1896, Part IV, page 2093.

At the first of the year the United States snag boat *E. A. Woodruff* was at Portsmouth, Ohio, 355 miles below Pittsburg, engaged in removing a portion of the ice pier, the two outer cribs of which had decayed and fallen to pieces, thereby obstructing navigation. This work was suspended on July 12, 1901, in order to permit a general clearing of the river channels while the stage of water was favorable for that purpose, the work remaining to be done on the ice pier being carried on, by hired labor, as a part of the general improvement of the Ohio River.

On leaving Portsmouth, the snag boat proceeded up-river to Gallipolis Island, and thence downstream to Paducah, Ky., thence back to Davis Island dam, and thence to Cincinnati, where she arrived on October 5. After remaining there for necessary repairs until October 11, operations were continued until October 26 over the stretch of river 246 miles long, commencing at Charleston bar, 412 miles below Pittsburg, and extending to Leavenworth, Ind. The depth of water on bars in the lower river having by that time fallen to nearly 3 feet, snagging operations by the *Woodruff* became impracticable and were discontinued until December 11. During the period of service commencing July 1 and ending October 26, 1901, the *Woodruff*, in addition to her work at the Portsmouth ice pier, removed 856 obstructions to navigation, including 825 snags, 27 wrecks, and 947 cubic feet of rocks.

To provide for low-water snagging while the *Woodruff* was idle between October 26 and December 11, work was continued by three hired plants, each consisting of a light-draft steamboat and flatboat, manned by details from the crew of the snag boat, and equipped in part from her outfit. This plant worked over the worst portions of the river from Brush Creek, 387 miles below Pittsburg, to the mouth of the river and removed 425 obstructions to navigation, including 408 snags, 5 wrecks, and 4,202 cubic feet of rocks.

The river having now regained a sufficiently high stage, and work by the hired plants at an end, the snag boat left New Albany on December 11 for Pittsburg, but stopped at Cincinnati on account of severe weather and danger from ice, and waited for better conditions; but they continued unfavorable, and on the 31st the boat was placed in winter quarters. In the meantime, December 16–18, the boat had removed the wreck of a coal barge from the channel adjoining the lower dike at Rising Sun, Ind., 35 miles below Cincinnati.

The boat was again put in temporary commission from January 21 to February 4, 1902, for the special purpose of clearing the channel at Rising Sun of another coal-barge wreck that threatened a complete obstruction of navigation; this barge was removed January 23, and on the day following another similar wreck was removed at Hoagland bar about 50 miles farther downstream. Then, en route back to Cincinnati, several snags and the wreck of a steel barge were removed. The boat again went in winter quarters February 3, and crew was discharged, except those required for proper care of the vessel and property.

The crew was again put on board May 1–5, the vessel made ready for the present season's work by May 20, and has continued in active service since that date, the general itinerary of her movements to June 30 being as follows: May 21 to May 31, inclusive, Cincinnati to Cairo and return; June 2 to June 28, Cincinnati to Wheeling and return, and at her Cincinnati berth the two following days to the close of the fiscal year. The stage of water was generally quite unfavorable for snagging operations during this period, but nevertheless the boat did some valuable work in removing 94 snags, 1 steamboat wreck (the

Relief), 9 coal boats and barges, and 3 steel barges, in the course of 2,111 miles of travel.

The total record of obstructions removed by the *Woodruff* during the fiscal year was: Snags, 919; rocks, 21,292 cubic feet; wrecks, 40 (viz, 3 steamboats, and 37 barges, flats, etc.). The total distance traveled in connection with the work was 5,274 miles.

Besides the work above reported, several wrecks, scattered rock, etc., were blown up and removed from the low-water channel, as follows: A sunken coal boat at mouth of Big Sewickley Creek; coal barge opposite Shousetown, Pa.; part of coal barge and a coal boat near Deadmans Island; 2 coal boats near Montgomery Island, and a sunken fuel flat and coal barge at Line Island. The United States steam launch *Wenonah* was utilized for this work, which was done at intervals from December 12, 1901, to March 25, 1902, by a small force of men under the direction of Inspector S. H. Fowler. The points where work was done are in the upper section of the river at distances ranging from 11 to 41 miles below Pittsburg. Another small party, under Suboverseer George W. Gibson, worked downstream on a quarter boat with a small flat from September 27 to November 16, inclusive, removing loose rock and other obstructions from the channel at points between Davis Island dam and the foot of Raccoon bar, a distance of 28½ miles. In this way 391 cubic yards of loose rock and 7 snags were removed and low-water navigation in that part of the river much benefited.

In addition to obstructions removed from the channel, 29 snags, piles, and pieces of wrecks found lying along the shore were destroyed or broken up by the crew of the snag boat, thereby providing as far as possible against a chance of becoming dangerous to navigation.

While the snag boat was in winter quarters (February 3 to May 20) miscellaneous repairs were made to the hull and machinery as follows: Minor repairs to wood work, $21.80; roof and deck covering, $165.73; painting, lettering, etc., $190.55; electric generating machinery, $35.50; electric searchlight, $234; storage batteries, $175; main engines, $44.15; capstan engines, $55.50; boilers, $121.07; sparring outfit, $181.44; total, $1,224.74.

The snag boat *Woodruff* is a powerful and finely equipped vessel and does admirable service during moderate stages of water, but can do little or nothing when the river is at a stage of less than 3.5 feet, though it is at such stages that snagging operations should be prosecuted most advantageously. With no light draft snag boat available, it becomes necessary at low stages each year to extemporize several outfits for the work, and this causes much loss in time, while the outfits themselves are of necessity but little better than makeshifts; though useful results are thereby obtained, they do not approximate what could be gained if one or two light-draft boats, properly equipped and adapted for this work, formed a part of the regular plant pertaining to the general improvement of the Ohio River. Such boats would also be most useful for many other important purposes in prosecuting the work of improvement, and, in my opinion, arrangements should be made for obtaining them as soon as practicable.

List of steamboat wrecks, by name, removed from the Ohio River during the fiscal year ending June 30, 1902.

Name.	Location.	Miles below Pittsburg.
Princess	Beaver Shoal	26.5
City of Golconda	Above Paducah, Ky	915
Relief	Rising Sun, Ind	502

LIST OF CONTRACTS IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1902.

Constructing one steam launch.—The Charles Hegewald Company, May 24, 1901; approved June 8, 1901; be prepared to commence twenty days after receipt of notification of approval of contract; terminate in three months; extended to November 15, 1901; extended to December 10, 1901; completed December 10, 1901.

Summary of expenditures for operating snag boats on Ohio River for the fiscal year ending June 30, 1902.

Office expenses and superintendence	$3,018.69
Service	22,280.76
Subsistence	5,328.79
Hire of plant	2,772.05
Fuel	2,978.33
Explosives, etc	373.17
General supplies and expenses	3,602.89
Care and repair of plant	1,061.66
Additions to plant	587.80
Total	42,004.14

D D 4.

FINAL REPORT ON SURVEY OF OHIO RIVER FROM MARIETTA TO MOUTH OF THE BIG MIAMI.

[Printed in House Doc. No. 336, Fifty-seventh Congress, first session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, January 25, 1902.

SIR: The river and harbor act of March 3, 1899, in the item making appropriation for improvement of the Ohio River, authorized a survey to be made of the river from Marietta, Ohio, to the mouth of the Big Miami River, the full text of the item being quoted in the accompanying report.

Preliminary report on the subject, dated April 17, 1900, by Maj. W. H. Bixby, Corps of Engineers, was submitted to Congress and is printed in House Doc. No. 648, Fifty-sixth Congress, first session, also in the Annual Report of the Chief of Engineers for 1900, page 3201 et seq.

I have now the honor to submit herewith a copy of final report, dated January 14, 1902, with maps,[a] upon the subject, by Major Bixby, who presents a definite plan for construction within the limits covered by the survey of 20 movable dams with locks, Nos. 19–38, inclusive, at an estimated cost ranging from $950,000 to $1,100,000 each, or a total of $19,950,000, the object of the proposed improvement being to provide a navigable depth of 6 feet at low water.

Assuming that the proposed improvement is intended to extend down to the mouth of the Big Miami, the survey was carried below that point as far as Petersburg, Ky.

The estimate includes the sum of $1,050,000 for a dam in the vicinity of Cullums Ripple, below Cincinnati, a separate estimate for which was submitted in report of February 10, 1899 (printed in House Doc. No. 265, Fifty-fifth Congress, third session, and in the Annual Report of the Chief of Engineers for 1899, pp. 2367–2371).

The report contains suggestions for the economical prosecution of the work and recommendations for commencing work at five localities with reference to their commercial importance, as follows:

1. Below Cincinnati, Ohio.
2. Below Point Pleasant, W. Va., and Gallipolis, Ohio.
3. Below Parkersburg, W. Va.
4. Below Catlettsburg, Ky.
5. Below Portsmouth, Ohio.

In the opinion of Major Bixby, improvement of the river in the manner and to the extent indicated is worthy of being undertaken by the United States, and his views are concurred in by Col. G. J. Lydecker, Corps of Engineers, Division Engineer.

A report on survey of the Ohio River from Marietta to Pittsburg, required by the terms of the river and harbor act of June 3, 1896, and containing a definite project for the construction of locks and dams in that portion of the river between the existing Dam No. 6 and a point a few miles below Marietta, with a view to providing a depth of 6 feet at low water, was transmitted to Congress in 1899 and is printed in House Doc. No. 122, Fifty-fifth Congress, third session, and in the Annual Report of the Chief of Engineers for 1899, on pages 2361–2366. The river and harbor act of March 3, 1899, made provision for carrying out part of the work outlined in the last-named project, and operations in connection therewith are now in progress.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. ELIHU ROOT,
Secretary of War.

REPORT OF MAJ. W. H. BIXBY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, January 14, 1902.

GENERAL: I have the honor to submit herewith the following final report on a survey of the Ohio River from Marietta, Ohio, to the mouth of the Big Miami River, made in compliance with section 1, river and harbor act of March 3, 1899, and pursuant to instructions of the Secretary of War of April 10, 1899, and of your office of April 11, 1899. This report is accompanied by 22 drawings, showing the locations of the proposed dams in plan as well as in profile.

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[a] Not reprinted; printed in House Doc. No. 336, Fifty-seventh Congress, first session.

The wording of the act of March 3, 1899, in which this work is provided for, is as follows:

> Improving Ohio River from its head to its mouth: Continuing improvement, * * * of which amount the Secretary of War is hereby authorized to expend $35,000, or so much thereof as may be necessary, upon a survey of said Ohio River from Marietta, Ohio, to the mouth of the Big Miami River, with a view to the improvement of said river between said points by movable dams and otherwise, so as to provide 6 feet of water in said river at low water, this survey to include a report upon the location of the necessary dams and the probable cost thereof.

It is assumed that the phraseology of the act looks to securing the desired 6 feet depth down to the mouth of the Big Miami, to do which will require that the last dam be placed somewhere below the last-named point and not immediately at or above it.

The object apparently desired by those interested in securing this survey is the continuation of the similar improvement already provided for on this river above Marietta by past appropriations and the construction of dams of a nature much similar to that already in successful operation at Davis Island, near Pittsburg, at the head of the Ohio River, and those in construction or under approved projects between Davis Island and Marietta.

In my opinion, the improvement of the above-named portion of the Ohio River in the manner and to the extent named is worthy of being undertaken by the General Government, and its execution, as shown below, will require the construction of 20 movable dams, at a total estimated cost of $19,950,000.

The planning for a system of dams of such character necessarily requires that the preliminary surveys be made with special care and accuracy. The nature of such surveys, the conditions which dam locations on the Ohio River must fulfill, the extent and order of work necessary to secure the sites, to construct the dams, to complete the channels through the connecting pools, and to secure a satisfactory service of the same has already been explained in considerable detail by me in a former report, dated December 28, 1898, upon the similar surveys for the similar system of dams in this river above Marietta (see House Doc. No. 122, Fifty-fifth Congress, third session; reprinted on pages 2361–2366, Annual Report of the Chief of Engineers for 1899), which report has already received the favorable indorsement of Congress in the shape of appropriations for Dams Nos. 13 and 18, referred to therein. The general descriptions and provisions of the report of December 28, 1898, apply equally to dams on the Ohio River between Marietta and the Big Miami; the present report supposes their continuance, and the present estimates are made under such supposition.

The method of such work is briefly stated as follows:

The survey is commenced with a traverse (or base) line, used also as a line of precise levels, following closely the bank of the river and reaching from the point farthest upstream to that farthest downstream within the limits of the survey. This traverse line and precise-level work serves as a basis of the entire survey, is the most important element in determining the general location of dams, and is later utilized by the Government in the preparation of harbor-line maps along pools above each dam and by town and city and county engineers along the river in their future engineering work. For the immediate necessities of dam locations, as well as for the reputation of the Government, such precise-level work must be done with great accuracy. It is therefore checked by two independent sets of observations, and is rejected and done over again whenever any errors are detected in excess of 0.01 foot per mile. At the few points where possible such precise-level line is connected with the existing bench marks of the United States Coast and Geodetic Survey, whose work is thereby utilized.

In connection with the precise leveling, cross-section levels from the water surface up to usually above freshet line are also made at intervals of about 400 feet up and down stream, such levels being required to be accurate within 0.02 foot per mile. For future reference during future construction work metallic monuments are buried in the ground at intervals of 1 mile up and down stream near the established mile points. The elevation of these metallic monuments and of all points determined by the survey is computed and recorded to show their heights above mean sea level at Sandy Hook, N. J., based upon comparison with the bench marks of a former level line run by the United States Coast and Geodetic Survey from Sandy Hook, N. J., to Parkersburg, W. Va., and known as one of the transcontinental lines of that Department. The precise-level party is closely followed by a topographic and hydrographic party, by whom soundings are made across the river in cross sections, spaced at intervals of about 400 feet up and down stream along deep pools and at intervals of about 200 feet along shoals and bars, the soundings in each cross section being spaced at intervals of about 40 feet.

In order to determine the local low water along the river, special temporary water gauges are established at intervals of about 20 miles up and down the river, and such water gauges are read two or more times per day throughout the continuance of field work. Wherever possible the lowest known low water and the highest freshet in the neighborhood of the gauge are also determined and recorded.

After the end of field work the results of topography and hydrography are plotted in the office on maps showing the same in plan on a scale of 1 inch to 200 feet (1:2,400) for use in studying the general and exact locations of dams and for future general reference. As finished, these maps, if in a single piece, would make a roll about 3 feet wide and nearly 700 feet in length. The size of this roll naturally forbids its reproduction for publication or general distribution. The detailed locations of the dams are made on the detailed maps, but for the purposes of preliminary study and of this final report special smaller maps (herewith appended) are prepared to show the low-water surface and the channel bottom of the river in profile on a scale of 1 inch to 5,000 feet (1:60,000) horizontally and 1 inch to 4 feet (1:48) vertically.

Upon both sets of maps all points of the low-water surface, bottom, and banks are referenced by their heights above mean sea level. At places where it is desirable to know the existing limits of low-water channels, contour lines are drawn upon the hydrographic maps to show depths in the river at the local low-water stage.

Such work for the length of river from Marietta to Petersburg (a few miles below the Big Miami) has now been completed, and the location of the proposed dams has been based thereon.

After the general location of dams has been determined on the profile maps, its more careful location is studied on the topographic and hydrographic maps, so as to render it, as far as possible, subject to the following conditions:

First. To allow room in the river for a navigable pass 600 feet wide above Point Pleasant (the mouth of the Kanawha) and 700 feet below that point, with its center nearly in line with the existing channel at towboat stages of water.

Second. To allow room in the river for weirs of at least 240 feet total length.

Third. To allow room in the river for the passage of coal tows around each half of the dam during construction of the other half.

Fourth. To allow of the sill or bottom of the navigable pass being placed at least slightly above the present bed of the river and yet at least as far below the water surface as are the channel bars, which, at coal-boat stages, determine the available depth of the river in the pools above and below.

Fifth. To avoid positions where coal tows must be flanked or placed obliquely to the channel line by reason of river bends or oblique currents.

Sixth. To allow of the view of dams by approaching boats for distances of at least half a mile both up and down stream.

Seventh. To avoid positions near shifting sand or gravel bars and mouths of sand-bearing rivers, creeks, and runs, unless such bars and streams be below the dams on the weir side.

Eighth. To allow of positions below the mouths of large tributaries like the Little Kanawha, Kanawha, Guyandot, Big Sandy, Scioto, Licking, and Big Miami, near enough to extend navigation properly to the nearest dam in such tributary, but yet far enough below the mouth of such tributary to avoid trouble from deposits and flood overflows and to allow proper handling of boats entering or leaving such tributaries.

Ninth. To avoid the cutting up or otherwise injuring the existing harbors of large cities, especially Parkersburg, Pomeroy, Point Pleasant and Gallipolis, Huntington and Catlettsburg, Ashland and Ironton, Portsmouth and Cincinnati, Newport and Covington.

Tenth. To allow of good pools below the dams probably to be first constructed, below large cities and streams, into which coal tows can descend and assemble while waiting for higher water to carry them to other dams farther downstream.

Eleventh. To allow of distance from dams to the next ripple or sharp bar below sufficient to permit some improvement of the ripple by future dredging, while awaiting the building of the next dams, without spoiling the then existing good draft of water over the sill of the dams above the ripple.

Twelfth. To allow, as commerce develops and demands, an extra 3-foot depth for navigation, of dredging a 9-foot-depth channel from the lower end of the lock to a 9-foot depth in the pool below, without excessive cost and delays.

The first, second, and third conditions prevent locations in narrow parts of the river, and especially at islands where the back channel is bare at low water and of insufficient depth at coal-boat stages. The third condition prevents location within a half mile of the ends of islands or high mid-river bars. The fifth and sixth conditions prevent locations at sharp bends.

While all of these conditions can not be fulfilled at each location, still most of the dams have been successfully so located, and the departures from these conditions have been comparatively and remarkably slight.

The location and principal data, including estimated cost, of these dams thus located are as follows:

Dam No.	Distance below Pittsburg.	Bank next lock.	Low-water level.	Sill level, navigable pass.	Lift.	Lower pool level, 6-foot draft.	Estimated total cost.	Location as to near towns or streams.
	Miles.		*Feet.*	*Feet.*	*Feet.*	*Feet.*		
16........	143.6	Ohio....	....	....	....	586.6	....	Already located under previous surveys.
17........	164.3	W. Va ..	....	....	8.2	578.4	....	Do.
18........	179.3	Ohio....	....	....	8.2	570.2	....	Do.
19........	190.1	W. Va ..	557.6	556.4	7.8	562.4	$950,000	Below Parkersburg, W. Va., and Little Kanawha River.
20........	200.5	....do ...	551.5	549.7	6.7	555.7	1,000,000	Below Hockingport, Ohio, and Big Hocking River.
21........	206.1	....do ...	546.6	544.0	5.7	550.0	950,000	Between Reedville, Ohio, and Murraysville, W. Va.
22........	219.9	Ohio....	538.5	536.2	7.8	542.2	1,000,000	Below Ravenswood, W. Va.
23........	229.6	W. Va ..	529.6	528.4	7.8	534.4	1,000,000	Above Millwood, W. Va.
24........	241.7	Ohio....	522.7	520.6	7.8	526.6	1,050,000	Between Letart Falls and Pomeroy, Ohio.
25........	259.7	....do ...	514.9	513.3	7.3	519.3	1,000,000	Below Pomeroy, Ohio, and Middleport, Ohio.
26........	274.0	W. Va...	509.1	505.8	7.5	511.8	950,000	Below Kanawha River and Gallipolis, Ohio.
27........	287.8	....do ...	501.4	498.3	7.5	504.3	950,000	Below Chambersburg, Ohio, and Little Guyandot River.
28........	309.5	....do ...	492.5	490.8	7.5	496.8	950,000	Below Huntington, W. Va., and Big Guyandot River.
29........	320.1	Ohio....	484.8	483.3	7.5	489.3	950,000	Between Big Sandy River and Ashland, Ky.
30........	339.0	Ky	477.6	475.7	7.6	481.7	950,000	Below Greenup, Ky.
31........	358.3	Ohio....	470.0	468.2	7.5	474.2	950,000	Below Portsmouth, Ohio, and Scioto River.
32........	383.5	....do ...	462.8	460.8	7.4	466.8	1,000,000	Below Vanceburg, Ky.
33........	392.8	....do ...	458.6	455.3	5.5	461.3	1,000,000	Above Manchester, Ohio.
34........	419.2	....do ...	452.0	448.5	6.8	454.5	1,050,000	Below Ripley, Ohio.
35........	442.3	Ky	414.9	442.6	5.9	448.6	1,050,000	Above New Richmond, Ohio.
36........	458.3	....do ...	437.9	435.1	7.5	441.1	1,100,000	Above Cincinnati, Ohio.
37........	481.3	Ohio....	428.8	427.3	7.8	433.3	1,050,000	Below Cincinnati, Ohio, at Home City and between Cullums and Medoc bars.
38........	[*]503.0	Ind.[*] ...	[*]422.0	[*]420.0	[*]7.0	[*]426.0	1,050,000	Below Big Miami River and Aurora, Ind.
Total ..	....	....	....	....	....	....	19,950,000	

[*] The location, levels, etc., of the lowest dam, No. 38, are necessarily only approximate, and can not be advantageously made until new surveys are ordered and made over the river from the Big Miami to Louisville. The information already on file in the Cincinnati office is sufficient to indicate quite clearly that a good location for Dam No. 38 can easily be found near Rising Sun Bar (about 13 miles below the Big Miami) for properly connecting Dam No. 37, the one below Cincinnati, with No. 39, the first dam of the future Big Miami-Louisville series, and also that such dam can be constructed within the $1,050,000 allowed for above.

Prior to and during the actual construction of dams much dredging must be done, at, above, below, and between dams, to straighten the connecting channel ways, to remove such portions of bars as would prevent the passage of tows around dams during construction, to remove such temporary bars as are always caused, to a greater or less degree, by temporary works of construction, and to also remove the channel ends of old spur dikes so far as they may be obstructions to the improved navigation. Such dredging is a necessary accompaniment of dam construction in all navigable rivers. Its cost should naturally be considered a part of such construction, and such cost is therefore included in and covered by the estimates of this report, especially in connection with Dams Nos. 20 to 26, inclusive, and Dam No. 36.

Between Marietta and the lower end of the present survey below the mouth of the Big Miami the majority of the dams will, according to the information so far secured, be necessarily founded on gravel bottoms, like those already built or planned above Marietta. Where good rock bottom can be secured, it will of course be utilized as a means of adding to the strength of the dam; but the existence of this rock bottom will not materially affect the cost of the completed structure, and may, therefore, be neglected so far as concerns all questions of estimates of cost.

After appropriations are made for individual dams and before the actual construction of each dam is commenced, careful local surveys at each location are made, for which about $5,000 per dam should be allowed, to determine the nature of the subsoil of the river bed (affecting foundations and dredging) and of its banks (affecting abutments), and to determine many other questions necessarily pertaining to the purchase of the needed property and preliminary to the making of contracts and to the best adjustment of details concerning the economy of final construction. These local surveys may require some slight changes in the final exact location of the dams; but past experience at dams above Marietta indicates that such changes will diminish rather than increase the final cost of the dam, should best be made just prior to actual construction, and need not be considered as materially affecting the amount of appropriation necessary to insure the construction and completion of the dam.

After these detailed local surveys shall have been made the necessary property is sought and secured, requiring special funds immediately available. The cost of such property is a matter of much uncertainty, and will vary considerably at the various locations.

From past experience with dams in the river above Marietta, the cost of work below Marietta down to the Big Miami is estimated as follows:

For an average lock of 600 feet length and 110 feet width, with navigable pass of 600 feet length, and with weirs of 240 feet available openings, all arranged to provide 6 feet navigable depth in the shoalest parts of the improved channel of the pools, with an average lift at each dam of 7.2 feet:

Lock, including cofferdam, excavations, foundations, masonry, timber, and ironwork of fixed and movable parts, power plant, machinery, and accessories	$350,000
Navigable pass; same items as above	150,000
Weirs, piers, abutments; same items as above	170,000
Miscellaneous, including local surveys, purchase of sites, embanking, retaining, riprapping, and paving of banks, lock employees' houses, storehouses, other buildings, dredging of approaches to locks and passes, dredging of shoals and removal of obstructions in pools, engineering work of location, construction, and inspection, office work of engineering and disbursements, and other contingencies	200,000
Total	870,000

But the extra width and height of lock esplanade filling, extra length of weirs, and extra channel dredging, incident to the individual locations of the dams, increase the above estimates to final totals of from $950,000 to $1,100,000 at the individual dams as given in the detailed table above.

The total cost for the entire system of 20 dams, from No. 19 (above Parkersburg) down to No. 38 (below Big Miami), inclusive, is therefore estimated at $19,950,000.

Improved methods of work, such as may arise during the next few years, may reduce some of these estimates during the actual progress of work, while, on the other hand, unforeseen contingencies may somewhat increase such estimates; but the above estimates are made with the expectation that extra expenses in one direction will and may be covered by the saving in other directions, and it is believed that these estimates are as close as it is safe to depend upon at the present day, and they are, therefore, herewith submitted as a sufficient basis for the appropriations necessary to the commencement of work, as well as for showing the probable final cost of the completion of the slack-water system herewith described.

For the most economical prosecution of the work, appropriations should be so made that $25,000 per dam near Parkersburg, $35,000 per dam from there to below Portsmouth, and $50,000 near Cincinnati, should be immediately available for local surveys and purchase of sites (the unused portions to be later available for work of actual construction), in order to allow the necessary preliminary work on each dam being done considerably in advance of actual contracts and actual construction of the work. Past experience shows that nearly a year is needed at each lock for local surveys, examination of titles, and other legal work connected with the acquisition of sites; and, furthermore, that the price of property near any selected location rises very rapidly as soon as such location is approximately known. For such reasons, the progress of construction of these dams would be much simplified and hastened if a first appropriation to the extent of $700,000 could be made immediately available for the purchase of all the sites from Marietta to the Big Miami.

The most economical prosecution of the work further requires that after the sites have been secured, further appropriations should then be made in such way as to allow the progress of work at several locations at once, in order to reduce to as few years as possible all necessary interference with the regular river traffic. Past experience has shown that the construction of a single dam requires about one year for acquisition of site, at least two years for the construction of the lock, at least two years more for the navigable pass and weirs, and at least one year more for the installation of operating machinery, or at least six years in all. If there were no restrictions to such progress by reason of lack of funds, all locks could be built at the same time, after which each navigable pass could be commenced as soon as each lock was finished, and each set of weirs could be commenced as soon as each navigable pass was finished. Such method of construction would allow the completion of all the dams in the time now required to complete a single dam.

I am decidedly of the opinion that specially advantageous results to commerce, obtained with special quickness, will follow the construction of dams across the Ohio River whenever these dams are built a short distance below large tributaries and large cities, partly because the large harborages thus obtained in the Ohio River will afford fine places for the loading and unloading of coal fleets and other tows, and for the stoppage and assemblage of such fleets and tows while waiting favorable stages for departure up and down both the main river and its tributaries, and partly because such increased harborage will be most advantageously placed by being at the already established centers of population and freight communications, thus giving special stimulus to commerce and related business interests. Cincinnati, Newport, and Covington, at the mouth of the Licking, form together the largest center of commerce on the portion of the river now under survey. The Kanawha River has already been slack watered from its mouth to the head of navigation. The Little Kanawha River and the Big Sandy River have already been partially slack watered.

The Scioto River is the largest of the remaining tributaries. I therefore recommend strongly that the next dam to be built in the Ohio River be built below Cincinnati, the next one below Point Pleasant and Gallipolis (mouth of the Kanawha River), and the next three below Parkersburg (mouth of Little Kanawha), Catlettsburg (mouth of the Big Sandy), and Portsmouth (mouth of the Scioto); after which the rest of the dams between Pittsburg and the Big Miami should follow in the order which may at that time appear to the engineer in charge as the most useful to the general river commerce. The above estimate for 20 dams allows for the location of the first 5 at the points above named, and the after interpolation of the remaining 16 dams between such points and the termini of the present survey.

A report under date of February 10, 1899 (House Doc. No. 265, Fifty-fifth Congress, third session[a]), specially called for by Congress, has already been submitted as regards the construction of a dam at or near Cullums Ripple, below Cincinnati, the cost of such dam having been estimated at $1,050,000, of which $50,000 was recommended for immediate use for local surveys, purchase of sites, preparations for contract work, and commencement of actual construction. In that report I assumed that the object of the inquiry was to obtain a report upon such a dam as would secure the best results for the harbor of Cincinnati, and that the phraseology "at or near Cullums" would allow of a final location of the dam as far below Cullums as it could be placed and yet secure a channel depth opposite Cincinnati of not less than 6 feet at low-water stage. The farther downstream such dam be placed, under such conditions, the longer will be the available harbor of Cincinnati.

The present survey shows an excellent location near Home City, about half way between Cullums Ripple and Medoc Bar, the next bar farther downstream, so as to give a long pool above the dam, and another of fair length immediately below it for assemblage of coal tows after passing the lock. The recommendations of the report of February 10, 1899, are, therefore, herewith repeated to the effect that the construction of such a dam is advisable, and that its cost is estimated at $1,050,000. Whenever such appropriation is made for such a dam, the dam might perhaps be best designated as Dam No. 37 of this report, or as the "dam in the Ohio River at Home City, between Cullums Ripple and Medoc Bar, below Cincinnati, Ohio."

Very respectfully, your obedient servant,

W. H. Bixby,
Major, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

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[a] See pages 2367-2371, Annual Report of the Chief of Engineers for 1899.

[First indorsement.]

ENGINEER OFFICE, U. S. ARMY, CENTRAL DIVISION,
Cincinnati, Ohio, January 17, 1902.

Respectfully forwarded to the Chief of Engineers, United States Army.

I concur in the general features of the project of improvement outlined by Major Bixby, and also in his opinion that it is worthy of being undertaken by the General Government.

G. J. LYDECKER,
Colonel, Corps of Engineers,
Division Engineer, Central Division.

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